Appendix 5

Supplementary Material for Chapter 5

Part A
Method P

Appendix A

Method P

AMBIENT AIR ANALYSIS METHOD FOR DETERMINING AMBIENT ATMOSPHERIC CONCENTRATIONS OF SUSPENDED PARTICULATE MATTER NOMINALLY 10 MICROMETERS OR LESS IN AERODYNAMIC DIAMETER (PM10)

1. Principle and Applicability

1.1 Principle

A sampler draws a known quantity of ambient air through an inlet, which is designed to admit specified proportions of particles as a function of their aerodynamic diameter. The inlet is designed to mimic the deposition of particulate matter in the human lung.

The particle collection characteristics of an ideal sampler, one which matches the human lung particle deposition characteristics, are outlined in 5.1.j. The particulate matter collected with such a sampler is referred to as a suspended particulate matter nominally 10 micrometers or less in aerodynamic diameter, or abbreviated as PM10.

As does the human lung, the ideal sampler collects a declining fraction of particles as their diameter increases and an increasing fraction of particles as their diameter decreases. For example, as can be seen in 5.1.j., all particles less than 1.0 Fm in diameter are collected and no particles of 16 or more Fm in diameter are collected.

In the ideal sampler, the PM10 passes through the inlet and is collected on a filter. The net weight (mass) of particulate matter deposited on the filter is determined as the difference in filter weight before and after sampling. The concentration of PM10 is reported as mass of particulate collected per cubic meter of air sampled (micrograms per cubic meter) at normal sea level temperature and pressure (760 torr., 25EC).

1.2 Applicability

This method provides for the measurement in ambient air of the concentration of PM10 over a 24-hour period. The measurement process is nondestructive and the sample can be subjected to subsequent physical and chemical analyses.

2. Range

The lower limit of the mass concentration range is limited by the repeatability of filter tare weights, assuming the nominal air sample volume for the sampler. The upper range limit is determined by the point at which the sampler can no longer maintain the required flow. This limit is a complex function of particle type and size distribution which is not readily quantifiable.

3. Interferences

3.1 Loss of Volatile Particles

Volatile particles collected on filter material can be lost during shipment and/or storage of the filters. Filters should therefore be reweighed as soon as possible.

3.2 Artifact Particulate Matter

Filters that meet the alkalinity specifications (Section 6, paragraph 6.4) show little or no artifact sulfate. Loss of true nitrate is dependent on location and temperature, but for most locations, the errors are expected to be small.

4. Precision and Accuracy

4.1 Precision

The reproducibility of PM10 samplers must be within $\pm$15 percent of true value at the 95 percent confidence level, as assessed by collocation of samplers.

4.2 Accuracy

Sample accuracy is dependent on sampling effectiveness, flow measurement, and calibration. Sampling effectiveness is expressed as the ratio of the mass concentration of particles of a given size reaching the sample filter to the mass concentration of particles of the same size approaching the sampler. The particle size for 50 percent effectiveness is required to be 10 $\pm$ 1 micrometers.

5. Apparatus and Specifications

5.1 PM10 Sampler

The sampler shall be designed to:

a. draw the air sample, via reduced internal pressure, into the sampler inlet and through the filter at a uniform face velocity.

b. hold and seal the filter in a horizontal position so that sample air is drawn downward through the filter.

c. allow the filter to be installed and removed conveniently.

d. protect the filter and sampler from precipitation and prevent insects and other debris from being sampled.

e. minimize leaks that would cause error in the measurement of the air volume passing through the filter.

f. discharge exhaust air at a sufficient distance from the sampler inlet to minimize the sampling of exhaust air.

g. minimize the collection of dust from the supporting surface.

h. provide uniform distribution of particulate matter on the filter media such that the deposition on the four quadrants shall agree within 5 percent.

The sampler shall operate at a controlled flow rate specified by its designer or manufacturer, and it shall have an inlet system that provides particle size discrimination characteristics meeting all of the specifications in this document. The sampler inlet shall show no significant wind direction dependence. This requirement can generally be satisfied by an inlet shape that is circularly symmetrical about a vertical axis.

The sampler shall provide a means to measure the total flow rate during the sampling period. A continuous flow recorder is recommended. The sampler may be equipped with additional flow measurement devices if it is designed to collect more than one particle size fraction.

The sampler shall have an automatic flow control device capable of adjusting and maintaining the sample flow rate within ±10 percent for the sampler inlet over normal variations in line voltage and filter pressure drop. A convenient means must be provided to temporarily disable the automatic flow control device to allow calibration of the sampler's flow measurement device.

A timing/control device capable of starting and stopping the sampler shall be used to obtain an elapsed run time of 24 ±1 hour (1440 ± 60 minutes). An elapsed time meter, accurate to within 15 minutes, shall be used to measure sampling time. This meter is optional for samplers with continuous flow recorders if the sampling time measurement obtained by means of the recorder meets the ±15-minute accuracy specifications.

The sampler shall have an associated operation or instruction manual.

Since proper service and maintenance is critical to obtaining valid data, the user should adopt adequate and documented standard operating procedures.

5.2 The PM10 sampler shall meet the following criteria for sampling effectiveness at windspeeds from 2 to 24 kilometers per hour:

<u>Parameter</u>	<u>Criteria</u>
Liquid Particles	Expected mass concentration is Within ±10 percent of that predicted By the ideal sampler.
Solid Particles	Expected mass concentration no more than 5 percent above that obtained for liquid particles of the same size.
50 Percent Cutpoint	10 ± 1 Fm aerodynamic diameter
Reproducibility	15 percent coefficient of variation for three collocated samplers.

The sampling effectiveness of the ideal sampler is:

Particle Size (Fm)	Sampling Effectiveness
< 1.0	1.000
2.0	0.942
3.0	0.922
4.0	0.893
5.0	0.857
6.0	0.812
7.0	0.759
8.0	0.697
9.0	0.628
10.0	0.551
11.0	0.465
12.0	0.371
13.0	0.269
14.0	0.159
15.0	0.041
≥ 16.0	0.000

6. Filters

6.1 Filter Medium

No commercially available filter medium is ideal in all respects for all samplers. The user's goals in sampling determine the relative importance of various filter evaluation criteria (e.g., cost, ease of handling, physical and chemical characteristics, etc.) and consequently determine the choice among acceptable filters. Furthermore, certain types of filters may not be suitable for use with some samplers, particularly under heavy loading conditions (high mass concentrations), because of high or rapid increase in the filter flow resistance that would exceed the capability of the sampler's automatic flow controller. The specifications given below are minimum requirements to insure acceptability of the filter medium for measurement of PM10 mass concentrations.

6.2 Collection Efficiency

Greater than 99 percent as measured by DOP test (ASTM-2986) with 0.3 Fm particles at the sampler's operating face velocity.

6.3 Integrity

±5 Fg/m^3 (assuming sampler's nominal 24-hour air sample volume), measured as the concentration equivalent corresponding to the difference between the initial and final weights of the filter when weighed and handled under simulated sampling conditions (equilibration, initial weighing, placement on inoperative sampler, removal from sampler, re-equilibration, and final weighing).

6.4 Alkalinity

<0.005 milliequivalents/gram of filter as measured by ASTM-D202, following at least two months storage at ambient temperature and relative humidity.

7. Procedure

7.1 The sampler shall be operated in accordance with the general instructions given here and with the specific instructions provided in the sampler manufacturer's instruction manual.

Note: This procedure assumes that the sampler's flow rate calibration was performed using flow rates at ambient conditions (Q_a).

7.2 Inspect each filter for pinholes, particles, and other imperfections; establish a filter information record and assign an identification number to each filter. Careful handling of filters between preweighing and post-sampling is necessary to avoid errors due to damaged filters or loss of particulate.

7.3 Equilibrate each filter in the conditioning environment for at least 24 hours.

Filter Conditioning Environment

a. Temperature range: 15 to 30EC

b. Temperature control: $\underline{+}$3EC

c. Humidity: less than 50 percent relative humidity

7.4 Following equilibration, weigh each filter and record the presampling weight with the filter identification number.

7.5 Analytical Balance

The analytical balance must be suitable for weighing the type and size of filters required by the sampler. The range and sensitivity required will depend on the filter tare weight and mass loading. Typically, an analytical balance with a sensitivity of 0.1 mg is required for high volume SSI samplers (flow rates > 0.5 m^3/min).

7.6 Pre-Run Procedure

a. Air Sample Report – Prior to each run, record on the Air Sample Report: the reporting agency, station address, station name, instrument number and county, site, agency, and project codes. Figure P-1 shows an example of the Air Sample Report form.

b. Clean Filter Installation – the clean particulate filter is placed on the sampler and secured in place.

c. Flow Setting – The actual flow rate must be maintained as specified by the manufacturer in order to maintain the 10 Fm cutpoint of the inlet. This will require special care at elevations greater than 1000 feet above sea level in order to prevent errors due to reduced atmospheric density.

d. Elapsed Time Meter – Record the initial elapsed time meter reading on the Monthly Check Sheet.

7.7 Post-Run Procedure

a. Final Flow Meter Reading – Before removing the filter and flow chart, make sure that the recorder trace shows the final flow. If not, the sampler must be started to determine the final flow.

Remove the flow chart from the recorder and examine the trace for abnormalities. Note and investigate any abrupt changes in air flow. If the start and finish air flows are not representative of your geographic area, note this on the Air Sample Report under "Remarks".

b. Exposed Filter Removal – Grasp the exposed filter without toughing the darkened area. Fold it in half width-wise with the darkened side in. A satisfactory filter is one which has a uniform white border. Dark streaks into the border may indicate an air leak, which invalidates the sample. If there are insects on the filter, remove them carefully. Note on the Air Sample Report if the filter is torn or ruptured, if the start or finish times are not known, or if the flows are outside the specified range.

Note: A removable filter cartridge may be loaded and unloaded at the station operator's headquarters to avoid contamination and damage to the filter media.

c. Timer and Elapsed Time Meter Check – After each run, check how long the sampler ran by reading the elapsed time meter. Record the final elapsed time meter (ETM) reading. These ETM readings are used in calculating the concentration of collected particulates as they are more accurate than the time or flow chart times. Adjust the timers to meet the timer acceptance limits of 24 hours $\pm$ 15 minutes.

7.8 Equilibration

Equilibrate the exposed filter(s) in the conditioning environment for 24 hours and immediately after equilibration reweigh the filter(s) and record the weight(s) with the filter identification number(s).

8. Calibration

The Size Selective Inlet High Volume Sampler (SSI) is calibrated by establishing that the air sample velocity is designed to meet the particle deposition specifications given in Section 5 of this method. The SSI PM10 sampler is calibrated using an orifice transfer standard that has been standardized against a primary standard Roots meter. The orifice transfer standard is referenced to 25EC and 760 mm Hg. Two different types of orifice calibrators are available. One type uses multihole adapter plates to vary the flow. The second type has an adjustable flow restrictor. In either case, the calibrator is connected to a differential pressure gauge or slack tube manometer. Pressure drops and indicated flow meter readings are recorded and corrected for elevation, as necessary. Using the pressure drops, the standard (true) flowrates are calculated using the certification equation for the transfer standard. Finally, a working sampler calibration curve of standard flowrate vs. indicated flowrate is plotted. The field calibration procedure assumes that:

- elevations below 1,000 feet are equivalent to standard conditions.

- the effect of temperature on the indicated flowrate is negligible and therefore, is not used in the determination of the standard flowrate.

8.1 Apparatus

a. Orifice Calibrator Transfer Standard with certification equation

(1) A flow rate transfer standard, suitable for the flow rate of the sampler and calibrated against a primary standard that is traceable to NBS, must be used to calibrate the sampler's flow measurement device.

(2) The reproducibility and resolution of the transfer standard must be 2 percent or less of the sampler's operating flow rate.

(3) The flow rate transfer standard must include a means to vary the sampler flow rate during calibration of the sampler's flow measurement device.

b. 0-20" differential pressure gauge or slack tube manometer

c. Tygon tubing for static pressure connections

d. Faceplate adapter with "C" clamps

e. Flow charts for continuous recorder

f. Calibration report forms

g. Plastic cap for constant volume sampler sensor

8.2 "As Is" Calibration

Other than routine daily checks, sampler repairs or adjustments (brush changes, motor replacement, flow recorder changes, etc.) should not be made prior to the "as is" calibration. The sampler should be calibrated after each 800 hours of operations, if the sampler is moved to a different site or if the initial flow meter reading falls outside of specified tolerance limits.

Note: Some samplers use a closed loop control system to provide constant blower speed and sampler flow. The flow sensor is located in the throat of the filter holder assembly. Before calibrating this type of sampler, first cover the flow sensor with a plastic cap. After calibrating, remove the cap.

a. Open the PM10 sampler shelter and remove the filter holder. Secure the faceplate adaptor and orifice calibrator; then, tighten down the orifice calibrator. If using a variable resistance calibrator, simply secure the calibrator to the faceplate adaptor and turn the restrictor control fully counterclockwise so that the maximum flow will be obtained. Connect a section of tygon tubing from the orifice tap on the calibrator to one leg of the manometer. Open the other leg so that it is open to the atmosphere. A schematic diagram of a typical sampler flow calibration is shown in Figure P-2.

b. After the sampler has warmed up, turn the motor off and then on and allow the static pressure (ÎP) and indicated flow reading (Qing) to stabilize. Then, read the static pressure (ÎP) and indicated flow readings (Qind). The static pressure is read as the total displacement, in inches, of the manometer water column. Record the static pressure and the indicated flow readings on the PM10 Sampler Calibration Data Sheet (see Figure P-4 as an example). Repeat this step twice so that a total of three test runs are performed.

c. Repeat Step b for each of the remaining four load plates. When using the variable resistance calibrator, select four additional points equally spaced around the setpoint determined in Section 7.6 (two points above and two points below; see example in Figure P-4).

d. Remove the orifice calibrator from the sampler. Measure the indicated flow with a clean filter installed in the PM10 sampler and record this value on the bottom of the Calibration Data Sheet.

e. On the left side of the Calibration Data Sheet, sum the ÎP readings for each line (Runs 1-3) and record the sum under “SUM ÎP”; then calculate and record the average ÎP for each line (Points 1-5). On the right side of the data sheet, sum the Qind readings for each line (Runs 1-3) and record the sum under “SUM Qind”; then, calculate and record the average Qind for each line (Points 1-5).

f. Record the elevation of the sampler on the Calibration Data Sheet. If the elevation is less than 1,000 feet, no altitude correction is required. If the elevation is 1,000 feet or greater, apply an altitude correction factor.

g. Referring to the certification equation and using the corrected ÎP values calculated in f., above (or average ÎP values for locations less than 1,000 feet elevation), determine and record Qstd (transfer standard) for each point, where:

Qstd = Factor Corr ÎP

h. Using the data from the Calibration Data Sheet, plot a Calibration Graph Qstd (transfer standard) vs. Qind. Draw a straight line through the plotted points, or, if facilities are available, obtain a linear regression computer plot.

This line represents the working sampler calibration graph for the particular sampler elevation. A sample plot is shown in Figure P-5.

i. Using the tabulated values of average Qind, determine Qprev (PM10 Sampler) by referring to the previous sampler calibration curve (Qstd vs. Qind). Find the appropriate value of Qprev from the y-axis corresponding to Qind on the X-axis. Record Qprev on the Calibration Data Sheet for each line (points 1-5).

j. Sum the column Qstd (transfer standard), tabulated on the left side of the Calibration Data Sheet. Record this sum as "S_1".

k. Sum the Column Qprev (PM10 Sampler), determined in Step I; record this sum as "S_2".

l. Calculate the percent deviation from previous calibration using the equation listed on the bottom of the Calibration Data Sheet. Record the result.

m. Using the sampler calibration graph, convert the clean filter indicated air flow rate to standard air flow rate and record the result on the bottom of the Calibration Data Sheet.

n. Complete a Calibration Report (see Figure P-3). A copy should be kept at the sampling site and in the operating organization's headquarters file.

8.3 "Final" Calibration – A final calibration is required after specified maintenance is performed (brush changes, motor replacement, flow recorder changes), including maintenance to correct the average initial flow meter reading being out of tolerance, or to repeat a sampler calibration graph which is non-linear.

8.4 Blank Forms and Assistance – a sample copy of forms such as blank Calibration Data Sheets, as well as assistance in calibration procedures, can be obtained by contacting:

STATE OF CALIFORNIA
Air Resources Board
Aerometric Data Division
Quality Assurance Section
P.O. Box 2815
Sacramento, CA 95812

9. Calculations

9.1 Determine the average flow rate over the sampling period corrected to reference conditions as Q_{std}.

9.2 Calculate the total volume of air sampled as:

$$v = Q_{std} \times t$$

where:

v = total air sampled in standard volume units, std m^3;

t = sampling time, min.

9.3 Calculate the PM10 concentration as:

$$PM10 = \frac{(w_f - w_I) \times 10^6}{V}$$

Where:

PM10 = mass concentration of PM10, ug/std m^3;

W_f W_I = final and initial weights of filter(s) Collecting PM10 particles, g;

10^6 = conversion of g to ug.

24-HOUR DATA AIR SAMPLE REPORT

ADD-12 (Revised 7/84)

SAMPLE NO. (FILTER PAPER NO.) 5061134

LAB. NO.

REPORTING AGENCY: ARB

STATION ADDRESS: 7400 SUNRISE BLVD

STATION NAME: CITRUS HEIGHTS

ACTION	COUNTY	SITE	AGENCY	PROJECT
2	34	00293	A	11

INTERVAL	INSTRUMENT NO.	CARD I.D.
8	599	TP

SAMPLING CONDITIONS: A

LOCAL CONDITION CODES (ENTER APPROPRIATE CODE IN BOX AT LEFT)

A. NO UNUSUAL CONDITIONS
B. WIND-BLOWN SAND/DUST
C. CONSTRUCTION NEARBY
D. FARMING OPERATION NEARBY
E. FIRE NEARBY
F. SAMPLER MALFUNCTION (Explain in Remarks)
H. RAIN
Z. OTHER (Explain in Remarks)

DATE OF LAST CALIBRATION: YEAR 85 MONTH 03 DAY 01

SAMPLE COLLECTION DATA

	DATE YEAR	DATE MONTH	DATE DAY	TIME HOURS	TIME MIN.	FLOW METER READING	TRUE AIR FLOW (CFM)	FILTER PAPER WEIGHT (GRAMS)	CARD COL.	ELAPSED TIME METER (MIN.)
FINISH	85	05	25	24	00	38.0	40.5		19-27	60624.4
START	85	05	25	00	00	38.0	40.5	4.5541	28-36	59184.0
24-HOUR AVERAGE						38.0	40.5	NET:	NET:	1440.4

CALCULATIONS: FLOW (m^3/MIN.) = TOTAL AIR VOLUME (m^3) = CONCENTRATION (µG / M^3) =

C	POLLUTANT	ANALYSIS METHOD	UNITS	POLLUTANT CODE: POLLUTANT	METHOD	UNITS	S	ANALYSIS VALUE (µG/M³)	FACTOR	CARD COL.
1	PM10	SSI	µG/M³	81101		01				57-77
2	SULFATE		µG/M³	82403		01				57-77
3	NITRATE		µG/M³	82306		01				57-77
4			µG/M³							57-77
5			µG/M³							57-77
6										57-77

CALIFORNIA AIR RESOURCES BOARD
Aerometric Data Division
P.O. Box 2815, Sacramento, CA 95812

REMARKS:

	OPER.		ANA.	LAB ANA.	LOGGED
INITIALS	RY	RCC			
DATE	2/4/85	5/17/85			

Figure P-1
24-Hour Data Air Sample Report

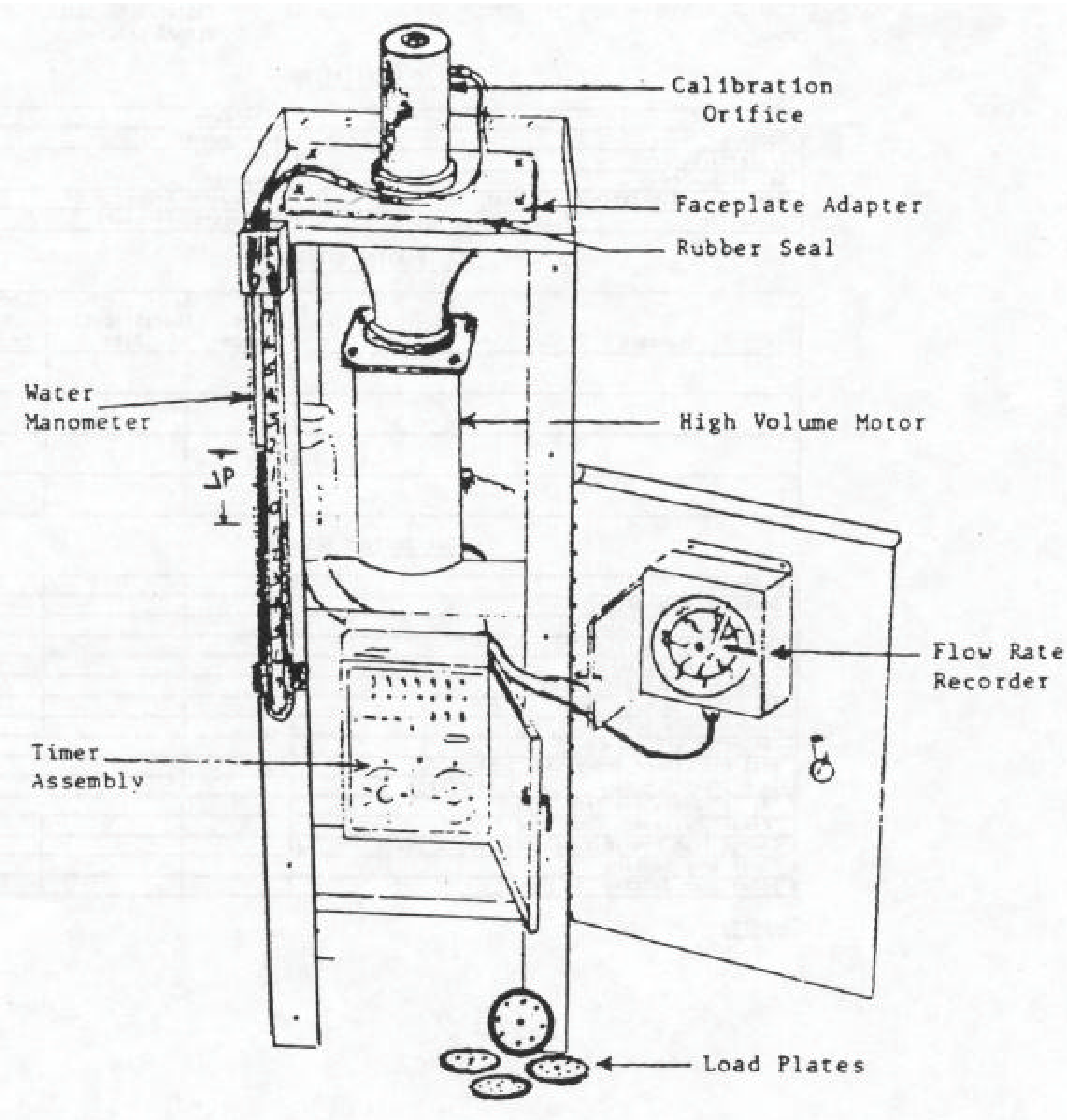


Figure P-2
PM10 Sampler Flow Calibration

CALIFORNIA AIR RESOURCES BOARD
CALIBRATION REPORT

TO:

FROM:

LOG NUMBER:
CALIBRATION DATE:
REPORT DATE:

IDENTIFICATION

Instrument		Site Name
Model Number		Site Number
Property Number		Site
Serial Number		Location
Previous Calibration Log Number		Instrument Property of
Elevation	Site Temperature °C	Barometric Pressure " Hg

CALIBRATION STANDARDS

Standard	I.D. Number	Certification Date	Certified Value Or Factor

CALIBRATION RESULTS

Component				
Instrument Range, ppm				
Initial Zero Setting				
Initial Span Setting				
Air Flow Rate, SLPH				
Air Flow Setting				
Reagent Flow Rate, SCCM				
Reagent Flow Setting				
Converter Efficiency				
Best Fit Linear Regression	Slope			
(x = True; Y =	Intercept			
"As Is" Deviation from True				
"Final" Deviation from True				
Change from Previous Calibration, % (date)				
Final Zero Setting				
Final Span Setting				

Comments

Calibrated By ____________________
ADD-25 (11/84)

Checked By ____________________

Figure P-3
Calibration Report

CALIFORNIA AIR RESOURCES BOARD
HIGH VOLUME SAMPLER/SSI CALIBRATION DATA SHEET

DATE 2/20/85 CALIBRATION: AS IS [ ] Final [X]

LOG NUMBER M 597 INSTRUMENT: HI-VOL [ ] SSI [X] FOR SSI ONLY: HEAD CUT POINT 40 µ

ORIFICE CALIBRATOR TRANSFER STANDARD	HIGH VOLUME SAMPLER BEING CALIBRATED
Make and Model: BGI	Make and Model: GMW
Property Number: 0513	Property No.: 5482 Altitude of Operation: 250'
Altitude Correction Factor*: 1.00 (≤ 1)	Property Of: ARB Date Last Calibrated: 8/22/85
Certification Equation: Airflow = 22.5 (factor) $\sqrt{\text{Corr } \Delta P}$	Location: Citrus Heights Station No.: 34-293

STATIC PRESSURE ΔP " H_2O			SUM ΔP	AVG ΔP	CORR[1] ΔP	Q_{std}[2]		INDICATED FLOW Q_{ind}			SUM Q_{ind}	AVG Q_{ind}	Q_{prev}[3]
RUN 1	RUN 2	RUN 3	" H_2O	" H_2O	" H_2O	SCFM		RUN 1	RUN 2	RUN 3	—	—	SCFM
4.9	5.0	5.0	14.9	5.0	5.0	50.3	POINT 1	50.0	50.0	49.5	149.5	49.8	49.9
4.0	3.9	4.0	11.9	4.0	4.0	45.0	POINT 2	43.5	44.0	44.5	132.0	44.0	44.7
3.2	3.0	3.0	9.2	3.1	3.1	39.6	POINT 3	38.0	38.0	38.0	114.0	38.0	39.3
2.4	2.4	2.4	7.2	2.4	2.4	34.9	POINT 4	33.0	33.0	32.5	98.5	32.8	34.6
1.8	1.8	1.8	5.4	1.8	1.8	30.2	POINT 5	27.0	28.0	28.0	83.0	27.7	30.0

Summation of Q_{std} (transfer standard), S_1 = 200.0 Summation of Q_{prev} (sampler), S_2 = 198.5

1. Corrected ΔP = Average ΔP x Altitude Correction Factor.
2. Q_{std} (transfer standard) is obtained from the certification equation listed above.
3. Q_{prev} (high volume sampler) is obtained from the last sampler calibration curve (Q_{std} vs. Q_{ind}).

% Deviation from Previous Calibration = $\frac{S_1 - S_2}{S_2} \times 100 = \frac{200 - 198.5}{198.5} \times 100\% = \boxed{+0.8\ \%}$

* Alt. Cor. Fac. = 1.001 x exp (-.0000371 x Altitude, feet) if Altitude >1000 feet; Otherwise = 1.000 (Note: Alt. Cor. Fac. $\leq$ 1.).

HI-Vol: Clean Filter: Indicated Flowrate = ________; Standard Flowrate = ________ SCFM (Set to 45 SLPM).
SSI: Clean Filter: Indicated Flowrate = 38.5; Standard Flowrate = 40.1 SCFM = 40.1 Actual CFM (Set to 40 Actual CFM).
For SSI Only: Actual CFM = SCFM Altitude Correction Factor.

Comments: ________

ADD-38 (5/85) Calibrated by J. Matson Checked by R. Cleary

Figure P-4
PM10 Sampler Calibration Data Sheet

CALIFORNIA AIR RESOURCES BOARD

High Volume Sampler/SSI Calibration Graph

Log No.: M 597

Station Name: Citrus Heights

Station Site No.: 34-293

Sampler Property No.: 0597

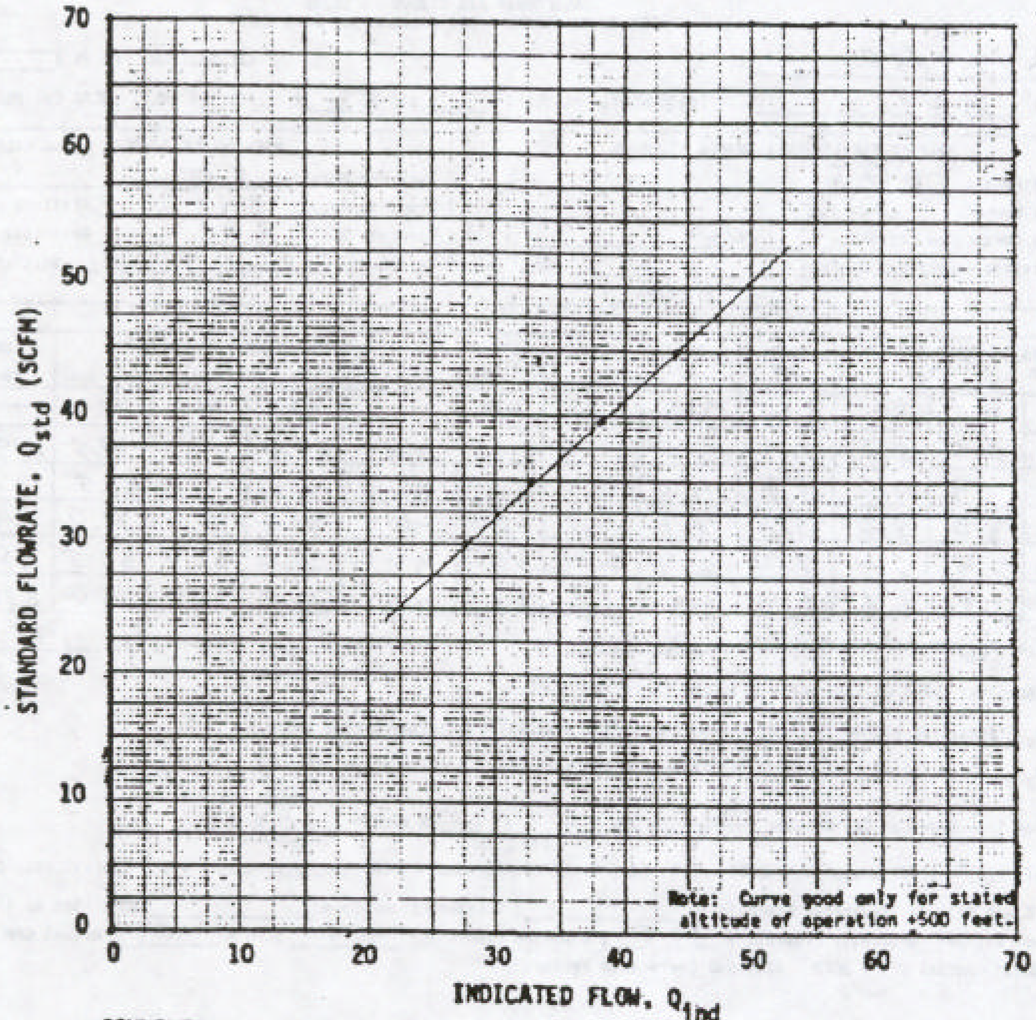
Sampler Make and Model No.: GMW

Date of Calibration: 2/20/85

"As Is" Calibration: ______

Final Calibration: ✓

Elevation: 250'



COMMENTS: ______

ADD-43 (5/85)

Graph prepared by J. Matson

Figure P-5
PM10 Sampler Calibration Graph

Appendix 5

Supplementary Material for Chapter 5

Part B

Appendix M to 40CFR, Part 50

7. Appendix M is added to read as follows:

Appendix M to Part 50—Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere

1.0 *Applicability.*

1.1 This method provides for the measurement of the mass concentration of particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{1O}) in ambient air over a 24-hour period for purposes of determining attainment and maintenance of the primary and secondary national ambient air quality standards for particulate matter specified in § 50.6 of this chapter. The measurement process is nondestructive, and the PM_{10} sample can be subjected to subsequent physical or chemical analyses. Quality assurance procedures and guidance are provided in part 58, Appendices A and B of this chapter and in references 1 and 2 of section 12.0 of this appendix.

2.0 *Principle.*

2.1 An air sampler draws ambient air at a constant flow rate into a specially shaped inlet where the suspended particulate matter is inertially separated into one or more size fractions within the PM_{10} size range. Each size fraction in the PM_{1O} size range is then collected on a separate filter over the specified sampling period. The particle size discrimination characteristics (sampling effectiveness and 50 percent cutpoint) of the sampler inlet are prescribed as performance specifications in part 53 of this chapter.

2.2 Each filter is weighed (after moisture equilibration) before and after use to determine the net weight (mass) gain due to collected PM_{10}. The total volume of air sampled, measured at the actual ambient temperature and pressure, is determined from the measured flow rate and the sampling time. The mass concentration of PM_{10} in the ambient air is computed as the total mass of collected particles in the PM_{10} size range divided by the volume of air sampled, and is expressed in micrograms per actual cubic meter ($\mu g/m^3$).

2.3 A method based on this principle will be considered a reference method only if the associated sampler meets the requirements specified in this appendix and the requirements in part 53 of this chapter, and the method has been designated as a reference method in accordance with part 53 of this chapter.

3.0 *Range.*

3.1 The lower limit of the mass concentration range is determined by the repeatability of filter tare weights, assuming the nominal air sample volume for the sampler. For samplers having an automatic filter-changing mechanism, there may be no upper limit. For samplers that do not have an automatic filter-changing mechanism, the upper limit is determined by the filter mass loading beyond which the sampler no longer maintains the operating flow rate within specified limits due to increased pressure drop across the loaded filter. This upper limit cannot be specified precisely because it is a complex function of the ambient particle size distribution and type, humidity, filter type, and perhaps other factors. Nevertheless, all samplers should be capable of measuring 24-hour PM_{10} mass concentrations of at least 300 $\mu g/m^3$ while maintaining the operating flow rate within the specified limits.

4.0 *Precision.*

4.1 The precision of PM_{10} samplers must be 5 $\mu g/m^3$ for PM_{10} concentrations below 80 $\mu g/m^3$ and 7 percent for PM_{10} concentrations above 80 $\mu g/m^3$, as required by part 53 of this chapter, which prescribes a test procedure that determines the variation in the PM_{10} concentration measurements of identical samplers under typical sampling conditions. Continual assessment of precision via collocated samplers is required by part 58 of this chapter for PM_{10} samplers used in certain monitoring networks.

5.0 *Accuracy.*

5.1 Because the size of the particles making up ambient particulate matter varies over a wide range and the concentration of particles varies with particle size, it is difficult to define the absolute accuracy of PM_{10} samplers. Part 53 of this chapter provides a specification for the sampling effectiveness of PM_{10} samplers. This specification requires that the expected mass concentration calculated for a candidate PM_{10} sampler, when sampling a specified particle size distribution, be within ±10 percent of that calculated for an ideal sampler whose sampling effectiveness is explicitly specified. Also, the particle size for 50 percent sampling effectiveness is required to be 10±0.5 micrometers. Other specifications related to accuracy apply to flow measurement and calibration, filter media, analytical (weighing) procedures, and artifact. The flow rate accuracy of PM_{10} samplers used in certain monitoring networks is required by part 58 of this chapter to be assessed periodically via flow rate audits.

6.0 *Potential Sources of Error.*

6.1 *Volatile Particles.* Volatile particles collected on filters are often lost during shipment and/or storage of the filters prior to the post-sampling weighing [3]. Although shipment or storage of loaded filters is sometimes unavoidable, filters should be reweighed as soon as practical to minimize these losses.

6.2 *Artifacts.* Positive errors in PM_{10} concentration measurements may result from retention of gaseous species on filters [4, 5]. Such errors include the retention of sulfur dioxide and nitric acid. Retention of sulfur dioxide on filters, followed by oxidation to sulfate, is referred to as artifact sulfate formation, a phenomenon which increases with increasing filter alkalinity [6]. Little or no artifact sulfate formation should occur using filters that meet the alkalinity specification in section 7.2.4 of this appendix, Artifact nitrate formation, resulting primarily from retention of nitric acid, occurs to varying degrees on many filter types, including glass fiber, cellulose ester, and many quartz fiber filters [5, 7, 8, 9, 10]. Loss of true atmospheric particulate nitrate during or following sampling may also occur due to dissociation or chemical reaction. This phenomenon has been observed on Teflon® filters [8] and inferred for quartz fiber filters [11, 12]. The magnitude of nitrate artifact errors in PM_{10} mass concentration measurements will vary with location and ambient temperature; however, for most sampling locations, these errors are expected to be small.

6.3 *Humidity.* The effects of ambient humidity on the sample are unavoidable. The filter equilibration procedure in section 9.0 of this appendix is designed to minimize the effects of moisture on the filter medium.

6.4 *Filter Handling.* Careful handling of filters between presampling and postsampling weighings is necessary to avoid errors due to damaged filters or loss of collected particles from the filters. Use of a filter cartridge or cassette may reduce the magnitude of these errors. Filters must also meet the integrity specification in section 7.2.3 of this appendix.

6.5 *Flow Rate Variation.* Variations in the sampler's operating flow rate may alter the particle size discrimination characteristics of the sampler inlet. The magnitude of this error will depend on the sensitivity of the inlet to variations in flow rate and on the particle distribution in the atmosphere during the sampling period. The use of a flow control device, under section 7.1.3 of this appendix, is required to minimize this error.

6.6 *Air Volume Determination.* Errors in the air volume determination may result from errors in the flow rate and/or sampling time measurements. The flow control device serves to minimize errors in the flow rate determination, and an elapsed time meter, under section 7.1.5 of this appendix, is required to minimize the error in the sampling time measurement.

7.0 *Apparatus.*

7.1 PM_{10} Sampler.

7.1.1 The sampler shall be designed to:

(a) Draw the air sample into the sampler inlet and through the particle collection filter at a uniform face velocity.

(b) Hold and seal the filter in a horizontal position so that sample air is drawn downward through the filter.

(c) Allow the filter to be installed and removed conveniently.

(d) Protect the filter and sampler from precipitation and prevent insects and other debris from being sampled.

(e) Minimize air leaks that would cause error in the measurement of the air volume passing through the filter.

(f) Discharge exhaust air at a sufficient distance from the sampler inlet to minimize the sampling of exhaust air.

(g) Minimize the collection of dust from the supporting surface.

7.1.2 The sampler shall have a sample air inlet system that, when operated within a specified flow rate range, provides particle size discrimination characteristics meeting all of the applicable performance specifications prescribed in part 53 of this chapter. The sampler inlet shall show no significant wind direction dependence. The latter requirement can generally be satisfied by an inlet shape that is circularly symmetrical about a vertical axis.

7.1.3 The sampler shall have a flow control device capable of maintaining the sampler's operating flow rate within the flow rate limits specified for the sampler inlet over normal variations in line voltage and filter pressure drop.

7.1.4 The sampler shall provide a means to measure the total flow rate during the sampling period. A continuous flow recorder is recommended but not required. The flow measurement device shall be accurate to ±2 percent.

7.1.5 A timing/control device capable of starting and stopping the sampler shall be used to obtain a sample collection period of 24 ±1 hr (1,440 ±60 min). An elapsed time meter, accurate to within ±15 minutes, shall be used to measure sampling time. This meter is optional for samplers with continuous flow recorders if the sampling time measurement obtained by means of the recorder meets the ±15 minute accuracy specification.

7.1.6 The sampler shall have an associated operation or instruction manual as required by part 53 of this chapter which includes detailed instructions on the calibration, operation, and maintenance of the sampler.

7.2 *Filters.*

7.2.1 *Filter Medium.* No commercially available filter medium is ideal in all respects for all samplers. The user's goals in sampling determine the relative importance of various filter characteristics, e.g., cost, ease of handling, physical and chemical characteristics, etc., and, consequently, determine the choice among acceptable filters. Furthermore, certain types of filters may not be suitable for use with some samplers, particularly under heavy loading conditions (high mass concentrations), because of high or rapid increase in the filter flow resistance that would exceed the capability of the sampler's flow control device. However, samplers equipped with automatic filter-changing mechanisms may allow use of these types of filters. The specifications given below are minimum requirements to ensure acceptability of the filter medium for measurement of PM_{10} mass concentrations. Other filter evaluation criteria should be considered to meet individual sampling and analysis objectives.

7.2.2 *Collection Efficiency.* ≥99 percent, as measured by the DOP test (ASTM–2986) with 0.3 μm particles at the sampler's operating face velocity.

7.2.3 *Integrity.* ±5 μg/m³ (assuming sampler's nominal 24-hour air sample volume). Integrity is measured as the PM_{10} concentration equivalent corresponding to the average difference between the initial and the final weights of a random sample of test filters that are weighed and handled under actual or simulated sampling conditions, but have no air sample passed through them, i.e., filter blanks. As a minimum, the test procedure must include initial equilibration and weighing, installation on an inoperative sampler, removal from the sampler, and final equilibration and weighing.

7.2.4 *Alkalinity.* <25 microequivalents/gram of filter, as measured by the procedure given in reference 13 of section 12.0 of this appendix following at least two months storage in a clean environment (free from contamination by acidic gases) at room temperature and humidity.

7.3 *Flow Rate Transfer Standard.* The flow rate transfer standard must be suitable for the sampler's operating flow rate and must be calibrated against a primary flow or volume standard that is traceable to the National Institute of Standard and Technology (NIST). The flow rate transfer standard must be capable of measuring the sampler's operating flow rate with an accuracy of ±2 percent.

7.4 *Filter Conditioning Environment.*

7.4.1 *Temperature range.* 15 to 30 C.

7.4.2 *Temperature control.* ±3 C.

7.4.3 *Humidity range.* 20% to 45% RH.

7.4.4 *Humidity control.* ±5% RH.

7.5 *Analytical Balance.* The analytical balance must be suitable for weighing the type and size of filters required by the sampler. The range and sensitivity required will depend on the filter tare weights and mass loadings. Typically, an analytical balance with a sensitivity of 0.1 mg is required for high volume samplers (flow rates >0.5 m³/min). Lower volume samplers (flow rates <0.5 m³/min) will require a more sensitive balance.

8.0 *Calibration.*

8.1 *General Requirements.*

8.1.1 Calibration of the sampler's flow measurement device is required to establish traceability of subsequent flow measurements to a primary standard. A flow rate transfer standard calibrated against a primary flow or volume standard shall be used to calibrate or verify the accuracy of the sampler's flow measurement device.

8.1.2 Particle size discrimination by inertial separation requires that specific air velocities be maintained in the sampler's air inlet system. Therefore, the flow rate through the sampler's inlet must be maintained throughout the sampling period within the design flow rate range specified by the manufacturer. Design flow rates are specified as actual volumetric flow rates, measured at existing conditions of temperature and pressure (Q_a).

8.2 *Flow Rate Calibration Procedure.*

8.2.1 PM_{10} samplers employ various types of flow control and flow measurement devices. The specific procedure used for flow rate calibration or verification will vary depending on the type of flow controller and flow rate indicator employed. Calibration is in terms of actual volumetric flow rates (Q_a) to meet the requirements of section 8.1 of this appendix. The general procedure given here serves to illustrate the steps involved in the calibration. Consult the sampler manufacturer's instruction manual and reference 2 of section 12.0 of this appendix for specific guidance on calibration. Reference 14 of section 12.0 of this appendix provides additional information on various other measures of flow rate and their interrelationships.

8.2.2 Calibrate the flow rate transfer standard against a primary flow or volume standard traceable to NIST. Establish a calibration relationship, e.g., an equation or family of curves, such that traceability to the primary standard is accurate to within 2 percent over the expected range of ambient conditions, i.e., temperatures and pressures, under which the transfer standard will be used. Recalibrate the transfer standard periodically.

8.2.3 Following the sampler manufacturer's instruction manual, remove the sampler inlet and connect the flow rate transfer standard to the sampler such that the transfer standard accurately measures the sampler's flow rate. Make sure there are no leaks between the transfer standard and the sampler.

8.2.4 Choose a minimum of three flow rates (actual m³/min), spaced over the acceptable flow rate range specified for the inlet, under section 7.1.2 of the appendix, that can be obtained by suitable adjustment of the sampler flow rate. In accordance with the sampler manufacturer's instruction manual, obtain or verify the calibration relationship between the flow rate (actual m³/min) as indicated by the transfer standard and the sampler's flow indicator response. Record the ambient temperature and barometric pressure. Temperature and pressure corrections to subsequent flow indicator readings may be required for certain types of flow measurement devices. When such corrections are necessary, correction on an individual or daily basis is preferable. However, seasonal average temperature and average barometric pressure for the sampling site may be incorporated into the sampler calibration to avoid daily corrections. Consult the sampler manufacturer's instruction manual and reference 2 in section 12.0 of this appendix for additional guidance.

8.2.5 Following calibration, verify that the sampler is operating at its design flow rate (actual m³/min) with a clean filter in place.

8.2.6 Replace the sampler inlet.

9.0 *Procedure.*

9.1 The sampler shall be operated in accordance with the specific guidance provided in the sampler manufacturer's instruction manual and in reference 2 in section 12.0 of this appendix. The general procedure given here assumes that the sampler's flow rate calibration is based on flow rates at ambient conditions (Q_a) and serves to illustrate the steps involved in the operation of a PM_{10} sampler.

9.2 Inspect each filter for pinholes, particles, and other imperfections. Establish a filter information record and assign an identification number to each filter.

9.3 Equilibrate each filter in the conditioning environment (see 7.4) for at least 24 hours.

9.4 Following equilibration, weigh each filter and record the presampling weight with the filter identification number.

9.5 Install a preweighed filter in the sampler following the instructions provided in the sampler manufacturer's instruction manual.

9.6 (a) Turn on the sampler and allow it to establish run-temperature conditions. Record the flow indicator reading and, if needed, the ambient temperature and barometric pressure. Determine the sampler flow rate (actual m³/min) in accordance with the instructions provided in the sampler manufacturer's instruction manual.

(b) Note: No onsite temperature or pressure measurements are necessary if the sampler's flow indicator does not require temperature or pressure corrections or if seasonal average temperature and average barometric pressure for the sampling site are incorporated into the sampler calibration, under section 8.2.4 of this appendix. If individual or daily temperature and pressure corrections are required, ambient temperature and barometric pressure can be obtained by on-site measurements or from a nearby weather station. Barometric pressure readings obtained from airports must be station pressure, not corrected to sea level, and may need to be corrected for differences in elevation between the sampling site and the airport.

9.7 If the flow rate is outside the acceptable range specified by the manufacturer, check for leaks, and if necessary, adjust the flow rate to the specified setpoint. Stop the sampler.

9.8 Set the timer to start and stop the sampler at appropriate times. Set the elapsed time meter to zero or record the initial meter reading.

9.9 Record the sample information (site location or identification number, sample date, filter identification number, and sampler model and serial number).

9.10 Sample for 24±1 hours.

9.11 Determine and record the average flow rate ($\bar{Q}_a$) in actual m³/min for the sampling period in accordance with the instructions provided in the sampler manufacturer's instruction manual. Record the elapsed time meter final reading and, if needed, the average ambient temperature and barometric pressure for the sampling period, in note following section 9.6 of this appendix.

9.12 Carefully remove the filter from the sampler, following the sampler manufacturer's instruction manual. Touch only the outer edges of the filter.

9.13 Place the filter in a protective holder or container, e.g., petri dish, glassine envelope, or manila folder.

9.14 Record any factors such as meteorological conditions, construction activity, fires or dust storms, etc., that might be pertinent to the measurement on the filter information record.

9.15 Transport the exposed sample filter to the filter conditioning environment as soon as possible for equilibration and subsequent weighing.

9.16 Equilibrate the exposed filter in the conditioning environment for at least 24 hours under the same temperature and humidity conditions used for presampling filter equilibration (see section 9.3 of this appendix).

9.17 Immediately after equilibration, reweigh the filter and record the postsampling weight with the filter identification number.

10.0 *Sampler Maintenance.*

10.1 The PM_{10} sampler shall be maintained in strict accordance with the maintenance procedures specified in the sampler manufacturer's instruction manual.

11.0 *Calculations.*

11.1 Calculate the total volume of air sampled as:

$$V = Q_a t$$

where:

V = total air sampled, at ambient temperature and pressure,m^3;

Q_a = average sample flow rate at ambient temperature and pressure, m^3/min; and

t = sampling time, min.

11.2 (a) Calculate the PM_{10} concentration as:

$$PM_{10} = (W_f - W_i) \times 10^6 / V$$

where:

PM_{10} = mass concentration of PM_{10}, $\mu g/m^3$;

W_f, W_i = final and initial weights of filter collecting PM_{1O} particles, g; and

10^6 = conversion of g to μg.

(b) Note: If more than one size fraction in the PM_{10} size range is collected by the sampler, the sum of the net weight gain by each collection filter [$\Sigma(W_f - W_i)$] is used to calculate the PM_{10} mass concentration.

12.0 *References.*

1. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I, Principles. EPA–600/9–76–005, March 1976. Available from CERI, ORD Publications, U.S. Environmental Protection Agency, 26 West St. Clair Street, Cincinnati, OH 45268.

2. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods. EPA–600/4–77–027a, May 1977. Available from CERI, ORD Publications, U.S. Environmental Protection Agency, 26 West St. Clair Street, Cincinnati, OH 45268.

3. Clement, R.E., and F.W. Karasek. Sample Composition Changes in Sampling and Analysis of Organic Compounds in Aerosols. Int. J. Environ. Analyt. Chem., 7:109, 1979.

4. Lee, R.E., Jr., and J. Wagman. A Sampling Anomaly in the Determination of Atmospheric Sulfate Concentration. Amer. Ind. Hyg. Assoc. J., 27:266, 1966.

5. Appel, B.R., S.M. Wall, Y. Tokiwa, and M. Haik. Interference Effects in Sampling Particulate Nitrate in Ambient Air. Atmos. Environ., 13:319, 1979.

6. Coutant, R.W. Effect of Environmental Variables on Collection of Atmospheric Sulfate. Environ. Sci. Technol., 11:873, 1977.

7. Spicer, C.W., and P. Schumacher. Interference in Sampling Atmospheric Particulate Nitrate. Atmos. Environ., 11:873, 1977.

8. Appel, B.R., Y. Tokiwa, and M. Haik. Sampling of Nitrates in Ambient Air. Atmos. Environ., 15:283, 1981.

9. Spicer, C.W., and P.M. Schumacher. Particulate Nitrate: Laboratory and Field Studies of Major Sampling Interferences. Atmos. Environ., 13:543, 1979.

10. Appel, B.R. Letter to Larry Purdue, U.S. EPA, Environmental Monitoring and Support Laboratory. March 18, 1982, Docket No. A–82–37, II–I–1.

11. Pierson, W.R., W.W. Brachaczek, T.J. Korniski, T.J. Truex, and J.W. Butler. Artifact Formation of Sulfate, Nitrate, and Hydrogen Ion on Backup Filters: Allegheny Mountain Experiment. J. Air Pollut. Control Assoc., 30:30, 1980.

12. Dunwoody, C.L. Rapid Nitrate Loss From PM_{10} Filters. J. Air Pollut. Control Assoc., 36:817, 1986.

13. Harrell, R.M. Measuring the Alkalinity of Hi-Vol Air Filters. EMSL/RTP–SOP–QAD–534, October 1985. Available from the U.S. Environmental Protection Agency, EMSL/QAD, Research Triangle Park, NC 27711.

14. Smith, F., P.S. Wohlschlegel, R.S.C. Rogers, and D.J. Mulligan. Investigation of Flow Rate Calibration Procedures Associated With the High Volume Method for Determination of Suspended Particulates. EPA–600/4–78–047, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, 1978.

8. Appendix N is added to read as follows:

Appendix N to Part 50—Interpretation of the National Ambient Air Quality Standards for Particulate Matter

1.0 *General.*

(a) This appendix explains the data handling conventions and computations necessary for determining when the annual and 24-hour primary and secondary national ambient air quality standards for PM specified in § 50.7 of this chapter are met. Particulate matter is measured in the ambient air as PM_{10} and $PM_{2.5}$ (particles with an aerodynamic diameter less than or equal to a nominal 10 and 2.5 micrometers, respectively) by a reference method based on Appendix M of this part for PM_{10} and on Appendix L of this part for $PM_{2.5}$, as applicable, and designated in accordance with part 53 of this chapter, or by an equivalent method designated in accordance with part 53 of this chapter. Data handling and computation procedures to be used in making comparisons between reported PM_{10} and $PM_{2.5}$ concentrations and the levels of the PM standards are specified in the following sections.

(b) Data resulting from uncontrollable or natural events, for example structural fires or high winds, may require special consideration. In some cases, it may be appropriate to exclude these data because they could result in inappropriate values to compare with the levels of the PM standards. In other cases, it may be more appropriate to retain the data for comparison with the level of the PM standards and then allow the EPA to formulate the appropriate regulatory response. Whether to exclude, retain, or make adjustments to the data affected by uncontrollable or natural events is subject to the approval of the appropriate Regional Administrator.

(c) The terms used in this appendix are defined as follows:

Average and *mean* refer to an arithmetic mean.

Daily value for PM refers to the 24-hour average concentration of PM calculated or measured from midnight to midnight (local time) for PM_{10} or $PM_{2.5}$.

Designated monitors are those monitoring sites designated in a State PM Monitoring Network Description for spatial averaging in areas opting for spatial averaging in accordance with part 58 of this chapter.

98^{th} *percentile* (used for $PM_{2.5}$) means the daily value out of a year of monitoring data below which 98 percent of all values in the group fall.

99^{th} *percentile* (used for PM_{10}) means the daily value out of a year of monitoring data below which 99 percent of all values in the group fall.

Year refers to a calendar year.

(d) Sections 2.1 and 2.5 of this appendix contain data handling instructions for the option of using a spatially averaged network of monitors for the annual standard. If spatial averaging is not considered for an area, then the spatial average is equivalent to the annual average of a single site and is treated accordingly in subsequent calculations. For example, paragraph (a)(3) of section 2.1 of this appendix could be eliminated since the spatial average would be equivalent to the annual average.

2.0 *Comparisons with the $PM_{2.5}$ Standards.*

2.1 *Annual $PM_{2.5}$ Standard.*

(a) The annual $PM_{2.5}$ standard is met when the 3-year average of the spatially averaged annual means is less than or equal to 15.0 $\mu g/m^3$. The 3-year average of the spatially averaged annual means is determined by averaging quarterly means at each monitor to obtain the annual mean $PM_{2.5}$ concentrations at each monitor, then averaging across all designated monitors, and finally averaging for 3 consecutive years. The steps can be summarized as follows:

(1) Average 24-hour measurements to obtain quarterly means at each monitor.

(2) Average quarterly means to obtain annual means at each monitor.

(3) Average across designated monitoring sites to obtain an annual spatial mean for an area (this can be one site in which case the spatial mean is equal to the annual mean).

(4) Average 3 years of annual spatial means to obtain a 3-year average of spatially averaged annual means.

(b) In the case of spatial averaging, 3 years of spatial averages are required to demonstrate that the standard has been met. Designated sites with less than 3 years of data shall be included in spatial averages for those years that data completeness requirements are met. For the annual $PM_{2.5}$ standard, a year meets data completeness requirements when at least 75 percent of the scheduled sampling days for each quarter have valid data. However, years with high concentrations and more than a minimal amount of data (at least 11 samples in each quarter) shall not be ignored just because they are comprised of quarters with less than complete data. Thus, in computing annual spatially averaged means, years containing quarters with at least 11 samples but less than 75 percent data completeness shall be included in the computation if the resulting spatially averaged annual mean concentration (rounded according to the conventions of section 2.3 of this appendix) is greater than the level of the standard.

(c) Situations may arise in which there are compelling reasons to retain years containing quarters which do not meet the data completeness requirement of 75 percent or the minimum number of 11 samples. The use of less than complete data is subject to the approval of the appropriate Regional Administrator.

(d) The equations for calculating the 3-year average annual mean of the $PM_{2.5}$ standard are given in section 2.5 of this appendix.

2.2 *24-Hour $PM_{2.5}$ Standard.*

(a) The 24-hour $PM_{2.5}$ standard is met when the 3-year average of the 98^{th} percentile values at each monitoring site is less than or equal to 65 $\mu g/m^3$. This comparison shall be based on 3 consecutive, complete years of air quality data. A year meets data completeness requirements when at least 75 percent of the scheduled sampling days for each quarter have valid data. However, years with high concentrations shall not be ignored just because they are comprised of quarters with less than complete data. Thus, in computing the 3-year

Appendix 5

Supplementary Material for Chapter 5

Part C
Table Comparing Method P (State Method) and the Federal Method (40CFR appendix M) for PM10 Samplers

Appendix C. Comparison of Method P (State Method) and the Federal method (40CFR appendix M) for PM10 samplers.

Parameter	**Method P**	**40CFR part 50 Appendix M**
1.0 Principle		1.1
1.2 Applicability .		1.0
2.0 Range	The lower limit of the mass concentration range is limited by the repeat-ability of filter tare weights, assuming the nominal air sample volume for the sampler. The upper range limit is determined by the point at which the sampler can no longer maintain the required flow. This limit is a complex function of particle type and size distribution which is not readily quantifiable.	3.0 Should measure 24hr PM10 mass concentration of at least 300 ug/m3 while flow rate is within limits For samplers with auto filter changer, No upper limit.
3 Interferences	3.1 Loss of Volatile particles Volatile particles collected on filter material can be lost during shipment and/or storage of the filters. Filters should therefore be reweighed as soon as possible. 3.2 Artifact Particulate Matter, negative error, positive error (alkalinity of filters) Filters that meet the alkalinity specifications (Section 6, paragraph 6.4) show little or no artifact sulfate. Loss of true nitrate is dependent on location and temperature but for most locations the errors are expected to be small**.**	6.1 Volatile particles 6.2 Artifacts, negative and <u>positive error</u> (gas adsorption on PM) 6.3 Humidity 6.4 Filter handling 6.5 Flow rate variation 6.5 Air volume determination
4. 1 Precision	Must be ± 15% of the true value at the 95 percent confidence level (collocated sampler	4.0 Must be 5 ug/m3 for [PM10] below 80 ug/m3, 7 percent for [PM10] above 80 ug./m3 (collocated samplers)
4.2 Accuracy	Sample accuracy is dependent on sampling effectiveness, flow measurement and calibration. Sampling effectiveness is expressed as the ratio of the mass concentration of particles of a given size reaching the sample filter to the mass concentration of particles of the same size approaching the sampler. The particle size for 50 percent effectiveness is required to be 10 ± 1 micrometers.	5.0 sampling effectiveness 10 ± 0.5 um 8.2.2 Flow rate accuracy of PM10 sampler: Part 58

Parameter	Method P	40CFR 50 Appendix M
5.1 PM10 sampler shall have	a. draw air sampler, via reduced internal pressure, into the sampler inlet and through the filter at a uniform face velocity b. hold and seal the filter in horizontal position so that sample air drawn downward through the filter c. allow the filter to be installed and removed conveniently d. protect the filter and sampler from precipitation and prevent insect and other debris from being sampled e. minimize leaks f. discharge exhaust air…. g. minimize the collection…. h. provide uniform distribution …	Section 7.1.1 Identical
5.2 Sampling effectiveness at wind speeds of 2 to 24 km/hr	Liquid particles ± 10% of that predicted by ideal sampler Solid particles, expected mass concentration no m ore than 5% above that obtained for liquid particles 50% cutpoint **10** ± **1** um aerodynamic diameter **Reproducibility 15% coefficient of variation for three collocated samplers** Wind speed 2 to 24 kph	Part 53.40 Table D-1 Expected mass conc. is the same For solids, the same **10** ± **0.5** um (above) **Precision (above)**) Wind speed 2 to 24 kph (the same)
5.2 sampler flow rate and inlet	The sampler shall operate at a controlled flow rate specified by its designed or manufacturer, and it shall have an inlet system that provides particle size discrimination characteristics meeting all of the specifications in this document. The sampler inlet shall show no significant wind direction dependence. This requirement can generally be satisfied by an inlet shape that is circularly symmetrical about a vertical axis**.**	7.1.2 Identical
5.3 Total flow control	5.3 The sampler shall provide a means to measure the total flow rate during the sampling period. A continuous flow recorder is recommended. The sampler may be equipped with additional flow measurement devices if it is designed to collect more than one particle size fraction.	7.1.4 Identical
5.4 Automatic flow control	5.4 The sampler shall have an automatic flow control device capable of adjusting and maintaining the sample flow rate within **±10** percent for the sampler inlet over normal variations in line voltage and filter pressure drop. A convenient means must be provided to temporarily disable the automatic flow control device to allow calibration of the sampler's flow measurement device.	7.1.3 The sampler shall have automatic flow control device capable of adjusting and maintaining the sample flow rate within the flow rate limits specified for the sampler inlet Table D-1 Part 53.41; The

		average flow rate over 24 hours within ± **5%** of initial flow rate; all measured flow rates over 24 hours within ±10% of initial flow rate
5.5 A timing/control device	5.5 A timing/control device capable of starting and stopping the sampler shall be used to obtain an elapsed rune time of 24 ± 1 hr (1440 ± 60 minutes). An elapsed time meter, accurate within 15 minutes, shall be used to measure sampling time.	7.1.5 Identical
5.6 Manual	5.6 The sampler shall have an associated operational or instructional manual	7.1.6 Identical
6. Filters		7.2 Filters
6.1 Filter medium	6.1 No commercially available filter medium is ideal for all respect for all samplers The user's goal in sampling determine the relative importance of various filter evaluation criteria (e.g. cost, ease of handling, physical and chemical characteristics, etc.)	7.2.1 Identical
6.2 Collection Efficiency	6.2 Greater than 99 percent as measured by DOP test (ASTM-2986) with 0.3 um particles as the sampler's operating face velocity	7.2.2 Identical
6.3 Integrity	6.3 Integrity ± 5 ug/m3 (assuming sampler's nominal 24-hour air sample volume) measured as the concentration equivalent corresponding to the difference between the initial and final weights of the filter when weighed and handled under simulated sampling conditions (equilibration, initial weighing, placement on inoperative sampler, removal from sampler, re-equilibration, and final weighing)	7.2.3 Identical
6.4 Alkalinity	6.4 Alkalinity < 0.005 milliequivalent/gram (< 5 microequivalent/gram) of filter as measured by ASTM-D202 following at least two months of storage at ambient temperature and relative humidity	7.24 Alkalinity < 2.5 microequivalent/gram
7 Procedure	7.1 The sampler shall operate in accordance with the specific guidance provided in the sampler manufacturer's instruction manual. This procedure assumes that the sampler's flow rate calibration was performed using flow rates at ambient conditions (Qa)	9.0 Identical
7.2 Filter inspection	7.2 Inspect each filter for pinholes, particles, and other imperfections; establish a filter information record and assign an identification number to each filter. Careful handling of filters between preweighing and post-sampling is necessary to avoid errors due to damaged filters or loss of particulate.	9.2 identical
7.3 Filter equilibration	7.3 Equilibrate each filter in the conditioning environment for at least 24 hours. Environmental. temperature range: 15 to 30^{o}C, b. Temperature control: $\underline{+}$3^{o}C , and c. humidity: less than 50 percent relative humidity RH < 50 percent	9.3 For 24-hour 15 to 30C, ± 3C temperature control, humidity range 20% to 45%,humidity control ± 5% RH
7.4 Filter weighing etc.	7.4 Following equilibration, weigh each filter and record the presampling weight with the filter identification number.	9.4 Identical
7.5 Analytical Balance	7.5 The analytical balance must be suitable for weighing the type and size of filters required by the sampler. The range and sensitivity required will depend on the filter tare weight and mass loading. Typically, an analytical balance with a sensitivity of 0.1 mg is required for high volume SSI samplers (flow rates > 0.5 m^3/min)	7.5 Identical, also includes sensitivity of 0.1 mg for <u>low volume samplers</u> (flow rate < 0.5 m3/min)

Parameter	Method P	40CFR 50 Appendix M
7.6 Pre-Run Procedure	a. Air Sample Report – Prior to each run, record on the Air Sample Report: the reporting agency, station address, station name, instrument number and county, site, agency, and project codes.	9.9 Identical
	b. Clean Filter Installation – the clean particulate filter is placed on the sampler and secured in place.	9.5
	c. Flow Setting – The actual flow rate must be maintained as specified by the manufacturer in order to maintain the 10 µm cutpoint of the inlet. This will require special care at elevations greater than 1000 feet above sea level in order to prevent errors due to reduced atmospheric density	8.2.4 and 9.6 manufacturer's manual
	d. Elapsed Time Meter – Record the initial elapsed time meter reading on the Monthly Check Sheet.	9.8
7.7 Post-Run Procedure	a Final Flow Meter Reading – Before removing the filter and flow chart, make sure that the recorder trace shows the final flow. If not, the sampler must be started to determine the final flow. Remove the flow chart from the recorder and examine the trace for abnormalities. Note and investigate any abrupt changes in air flow. If the start and finish air flows are not representative of your geographic area, note this on the Air Sample Report under “Remarks”.	9.11 and part of 9.6
	b Exposed Filter Removal – Grasp the exposed filter without toughing the darkened area. Fold it in half width-wise with the darkened side in. A satisfactory filter is one which has a uniform white border. Dark streaks into the border may indicate an air leak, which invalidates the sample. If there are insects on the filter, remove them carefully. Note on the Air Sample Report if the filter is torn or ruptured, if the start or finish times are not known, or if the flows are outside the specified range. Note: A removable filter cartridge may be loaded and unloaded at the station operator’s headquarters to avoid contamination and damage to the filter media.	9.12 manufacturer's manual
7.7 Post-Run	c. Timer and Elapsed Time Meter Check – After each run, check how long the sampler ran by reading the elapsed time meter. Record the final elapsed time meter (ETM) reading. These ETM readings are used in calculating the concentration of collected particulates as they are more accurate than the time or flow chart times. Adjust the timers to meet the timer acceptance limits of 24 hours ± 15 minutes.	9.11. and part of 7.1.5
7.8 Equilibration	Equilibrate the exposed filter(s) in the conditioning environment for 24 hours and immediately after equilibration reweigh the filter(s) and record the weight(s) with filter identification number(s).	9.16 and 9.17: Identical (al least 24 hours)
		9.10 Sample for 24 ± 1h r
		9.14 Record any factors such as meteorological conditions, construction activity, fires or dust storms, etc. that might be pertinent to the measurement on the filter information record
		9.15 Transport the exposed filters to the filter conditioning

		environment as soon as possible
Parameter	**Method P**	**40CFR 50 Appendix M**
8.Calibration	*Calibrated using an **orifice transfer** standard that has been standardized against a primary standard root s meter *The orifice standard is referenced to 25C and 760 mm Hg. *Two types of orifice standard: **multihole** adapter plates to vary the flow and an **adjustable flow** restrictor. In both, the calibrator is connected to a differential pressure gauge or slack tube manometer. *Pressure drops and indicated flow meter readings are recorded and corrected for elevation, as necessary. *Using the pressure drops, the standard (true) flow rates are calculated using the certified equation for the transfer standard. Finally a working sampler calibration curve of standard flow rate vs indicated flow rate is plotted. **Assumptions:** Elevation below 1000 feet is equivalent to standard conditions The effect of temperature on the indicator flowrate is negligible and therefore is not used in the determination of the standard flow rate.	8.0
8.1 Apparatus		
	a-1 A flow rate transfer standard, suitable for the flow rate of the sampler and calibrated against a primary standard that is traceable to NBS, must be used to calibrate the sampler's flow measurement device.	7.3
	a-2 The reproducibility and resolution of the transfer standard must be 2 percent or less of the sampler's operating flow rate	8.2.2
	a-3. The flow rate transfer standard must include a means to vary the sampler flow rate during calibration of the sampler's flow measurement device.	
	b- 0-20" differential pressure gauge or slack tube manometer	
	c- Tygon tubing for static pressure connections	
	d- Faceplate adapter with "C" clamps **.**	
	e- Flow charts for continuous recorder	
	f- Calibration report forms	
	g- Plastic cap for constant volume sampler sensor	

Parameter	Method P	40CFR 50 Appendix M
8.2 "As Is" Calibration	Other than routine daily checks, sampler repairs or adjustments (brush changes, motor replacement, flow recorder changes, etc.) should not be made prior to the “as is” calibration. The sampler should be calibrated after each 800 hours (nearly 33 days) of operations, if the sampler is moved to a different site, or if the initial flow meter reading falls outside of specified tolerance limits. Note: Some samplers use a closed loop control system to provide constant blower speed and and sampler flow. The flow sensor is located in the throat of the filter holder assembly. Before calibrating this type of sampler, first cover the flow sensor with a plastic cap. After calibrating, remove the cap	
	8.2a Open the PM10 sampler shelters and remove the filter holder. Secure the faceplate adapter and orifice calibrator; then, tighten down the orifice calibrator. If using a variable resistance calibrator, simply secure the calibrator to the faceplate adapter and turn the restrictor control fully counterclockwise so that the maximum flow will be obtained. Connect a section of tygon tubing from the orifice tap on the calibrator to one leg of the manometer. Open the other leg so that it is open to the atmosphere. A schematic diagram of a typical sampler flow calibration is shown in Figure P-2.	
	8.2b After the sampler has warmed up, turn the motor off and then on and allow the static pressure (ÎP) and indicated flow reading (Qing) to stabilize. Then, read the static pressure (ΔP) and indicated flow readings (Qind). The static pressure is read as the total displacement, in inches, of the manometer water column. Record the static pressure and the indicated flow readings on the PM10 Sampler Calibration Data Sheet (see Figure P-4 as an example). Repeat this step twice so that a total of three test runs are performed.	
	8.2c Repeat Step b for each of the remaining four load plates. When using the variable resistance calibrator, select four additional points equally spaced around the setpoint determined in Section 7.6 (two points above and tow points below; see example in Figure P-4).	
	8.2d Remove the orifice calibrator from the sampler. Measure the indicated flow with a clean filter installed in the PM10 sampler and record this value on the bottom of the calibration data sheet	
	8.2e On the left side of the calibration data sheet, sum the ΔP readings for each line (runs 1-3) and record the sum under the sum ΔP for each line (points 1-5). Etc.	
	8.2f Record the elevation of the sampler on the calibration data sheet. If elevation less than 1,000 ft, no correction is required. If the elevation is 1000 ft or grater, apply an altitude correction factor.	
	8.2g Referring to the certification of equation and using the corrected ΔP values calculated in f, above, determine the record Qsts 9transfer standard) for each point, where Qstd = factor Corr ΔP	
	8.2h Using the data from the calibration data sheet, plot a calibration graph Qstd vs. Qind. Draw a straight line through the plotted points, or, or obtain a linear regression plot. This line represents the working sampler calibration graph for the particular sampler elevation.	

Parameter	Method P	40CFR 50 Appendix M
	8.2i Using the tabulate values of the average Qind, determine Qperv (PM10 sampler) by referring to the pervious sampler calibration curve (Qstd vs Qind). Find the appropriate value of Qprev from the Y-axis corresponding to Qind on the x-axis.	
	8.2j Sum the column Qstd (transfer standard), tabulated on the left side of the calibration data sheet. Record this sum as “S1”	
	8.2k Sum the column Qprev (PM10 sampler), determine in Step I; record this sum as ‘S2”.	
	8.2l Calculate the percent deviation from the previous calibration using the equation listed on the bottom the calibration data sheet. Record the result.	
	8.2m Using the sampler calibration graph, convert the clean filter indicated air flow rate to standard air flow rate and record the result on the bottom the calibration data sheet.	
	8.2n Complete a Calibration Report (see Figure P-3). A copy should be kept at the sampling site and in the operating organization’s headquarters file.	
8.3 "Final" Calibration	A final calibration is required after specified maintenance is performed (brush changes, motor replacement, flow recorder changes), including maintenance to correct the average initial flow meter reading being out of tolerance, or to repeat a sampler calibration graph which is non-linear.	
8.4 Blank Form and Assistance	Blank Forms and Assistance – a sample copy of forms such as blank Calibration Data Sheets, as well as assistance in calibration procedures, can be obtained by contacting: STATE OF CALIFORNIA Air Resources Board Aerometric Data Division Quality Assurance Section P.O. Box 2815 Sacramento, CA 95812	
9. Calculations	9.1 Determine the average flow rate over the sampling period corrected to reference conditions as Q_{std}.	11.
	9.2 9.2 Calculate the total volume of air sampled as: $v = Q_{std} \times t$ where: v = total air sampled in standard volume units, std m^3; t = sampling time, min.	11.1
	9.3 9.3 Calculate the PM10 concentration as: $PM10 = \frac{(w_f - w_I) \times 10^6}{v}$ Where: PM10 = mass concentration of PM10, Fg/std m^3; W_f W_I = final and initial weights of filter(s) Collecting PM10 particles, g; 10^6 = conversion of g to µg.	11.2

Appendix 5

Supplementary Material for Chapter 5

Part D

Appendix L to 40CFR, Part 50

concentrations were 55, 68, 73, 92, 120, and 155 µg/m³. Applying the weighting factors specified in Equation 6, the quarterly mean is:

$$\bar{x}_q = (1/7)\times[(1/3)\times(202+242+180)+155+68+73+92+120+155=110.1$$

b. Although 24–hour measurements are rounded to the nearest 10 µg/m³ for determinations of exceedances of the 24–hour standard, note that these values are rounded to the nearest 1 µg/m³ for the calculation of means.

6. Appendix L is added to read as follows:

Appendix L to Part 50—Reference Method For the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere

1.0 *Applicability.*

1.1 This method provides for the measurement of the mass concentration of fine particulate matter having an aerodynamic diameter less than or equal to a nominal 2.5 micrometers ($PM_{2.5}$) in ambient air over a 24-hour period for purposes of determining whether the primary and secondary national ambient air quality standards for fine particulate matter specified in § 50.6 of this part are met. The measurement process is considered to be nondestructive, and the $PM_{2.5}$ sample obtained can be subjected to subsequent physical or chemical analyses. Quality assessment procedures are provided in part 58, Appendix A of this chapter, and quality assurance guidance are provided in references 1, 2, and 3 in section 13.0 of this appendix.

1.2 This method will be considered a reference method for purposes of part 58 of this chapter only if:

(a) The associated sampler meets the requirements specified in this appendix and the applicable requirements in part 53 of this chapter, and

(b) The method and associated sampler have been designated as a reference method in accordance with part 53 of this chapter.

1.3 $PM_{2.5}$ samplers that meet nearly all specifications set forth in this method but have minor deviations and/or modifications of the reference method sampler will be designated as ''Class I'' equivalent methods for $PM_{2.5}$ in accordance with part 53 of this chapter.

2.0 *Principle.*

2.1 An electrically powered air sampler draws ambient air at a constant volumetric flow rate into a specially shaped inlet and through an inertial particle size separator (impactor) where the suspended particulate matter in the $PM_{2.5}$ size range is separated for collection on a polytetrafluoroethylene (PTFE) filter over the specified sampling period. The air sampler and other aspects of this reference method are specified either explicitly in this appendix or generally with reference to other applicable regulations or quality assurance guidance.

2.2 Each filter is weighed (after moisture and temperature conditioning) before and after sample collection to determine the net gain due to collected $PM_{2.5}$. The total volume of air sampled is determined by the sampler from the measured flow rate at actual ambient temperature and pressure and the sampling time. The mass concentration of $PM_{2.5}$ in the ambient air is computed as the total mass of collected particles in the $PM_{2.5}$ size range divided by the actual volume of air sampled, and is expressed in micrograms per cubic meter of air (µg/m³).

3.0 *$PM_{2.5}$ Measurement Range.*

3.1 *Lower concentration limit.* The lower detection limit of the mass concentration measurement range is estimated to be approximately 2 µg/am³, based on noted mass changes in field blanks in conjunction with the 24 m³ nominal total air sample volume specified for the 24-hour sample.

3.2 *Upper concentration limit.* The upper limit of the mass concentration range is determined by the filter mass loading beyond which the sampler can no longer maintain the operating flow rate within specified limits due to increased pressure drop across the loaded filter. This upper limit cannot be specified precisely because it is a complex function of the ambient particle size distribution and type, humidity, the individual filter used, the capacity of the sampler flow rate control system, and perhaps other factors. Nevertheless, all samplers are estimated to be capable of measuring 24-hour $PM_{2.5}$ mass concentrations of at least 200 µg/m³ while maintaining the operating flow rate within the specified limits.

3.3 *Sample period.* The required sample period for $PM_{2.5}$ concentration measurements by this method shall be 1,380 to 1500 minutes (23 to 25 hours). However, when a sample period is less than 1,380 minutes, the measured concentration (as determined by the collected $PM_{2.5}$ mass divided by the actual sampled air volume), multiplied by the actual number of minutes in the sample period and divided by 1,440, may be used as if it were a valid concentration measurement for the specific purpose of determining a violation of the NAAQS. This value assumes that the $PM_{2.5}$ concentration is zero for the remaining portion of the sample period and therefore represents the minimum concentration that could have been measured for the full 24-hour sample period. Accordingly, if the value thus calculated is high enough to be an exceedance, such an exceedance would be a valid exceedance for the sample period. When reported to AIRS, this data value should receive a special code to identify it as not to be commingled with normal concentration measurements or used for other purposes.

4.0 *Accuracy.*

4.1 Because the size and volatility of the particles making up ambient particulate matter vary over a wide range and the mass concentration of particles varies with particle size, it is difficult to define the accuracy of $PM_{2.5}$ measurements in an absolute sense. The accuracy of $PM_{2.5}$ measurements is therefore defined in a relative sense, referenced to measurements provided by this reference method. Accordingly, accuracy shall be defined as the degree of agreement between a subject field $PM_{2.5}$ sampler and a collocated $PM_{2.5}$ reference method audit sampler operating simultaneously at the monitoring site location of the subject sampler and includes both random (precision) and systematic (bias) errors. The requirements for this field sampler audit procedure are set forth in part 58, Appendix A of this chapter.

4.2 Measurement system bias. Results of collocated measurements where the duplicate sampler is a reference method sampler are used to assess a portion of the measurement system bias according to the schedule and procedure specified in part 58, Appendix A of this chapter.

4.3 Audits with reference method samplers to determine system accuracy and bias. According to the schedule and procedure specified in part 58, Appendix A of this chapter, a reference method sampler is required to be located at each of selected $PM_{2.5}$ SLAMS sites as a duplicate sampler. The results from the primary sampler and the duplicate reference method sampler are used to calculate accuracy of the primary sampler on a quarterly basis, bias of the primary sampler on an annual basis, and bias of a single reporting organization on an annual basis. Reference 2 in section 13.0 of this appendix provides additional information and guidance on these reference method audits.

4.4 Flow rate accuracy and bias. Part 58, Appendix A of this chapter requires that the flow rate accuracy and bias of individual $PM_{2.5}$ samplers used in SLAMS monitoring networks be assessed periodically via audits of each sampler's operational flow rate. In addition, part 58, Appendix A of this chapter requires that flow rate bias for each reference and equivalent method operated by each reporting organization be assessed quarterly and annually. Reference 2 in section 13.0 of this appendix provides additional information and guidance on flow rate accuracy audits and calculations for accuracy and bias.

5.0 *Precision.* A data quality objective of 10 percent coefficient of variation or better has been established for the operational precision of $PM_{2.5}$ monitoring data.

5.1 Tests to establish initial operational precision for each reference method sampler are specified as a part of the requirements for designation as a reference method under § 53.58 of this chapter.

5.2 Measurement System Precision. Collocated sampler results, where the duplicate sampler is not a reference method sampler but is a sampler of the same designated method as the primary sampler, are used to assess measurement system precision according to the schedule and procedure specified in part 58, Appendix A of this chapter. Part 58, Appendix A of this chapter requires that these collocated sampler measurements be used to calculate quarterly and annual precision estimates for each primary sampler and for each designated method employed by each reporting organization. Reference 2 in section 13.0 of this appendix provides additional information and guidance on this requirement.

6.0 *Filter for $PM_{2.5}$ Sample Collection.* Any filter manufacturer or vendor who sells or offers to sell filters specifically identified for use with this $PM_{2.5}$ reference method shall certify that the required number of filters from each lot of filters offered for sale as such have been tested as specified in this section 6.0 and meet all of the following design and performance specifications.

6.1 *Size.* Circular, 46.2 mm diameter ±0.25 mm.

6.2 *Medium.* Polytetrafluoroethylene (PTFE Teflon), with integral support ring.

6.3 *Support ring.* Polymethylpentene (PMP) or equivalent inert material, 0.38 ±0.04 mm thick, outer diameter 46.2 mm ±0.25 mm, and width of 3.68 mm (±0.00, -0.51 mm).

6.4 *Pore size.* 2 µm as measured by ASTM F 316–94.

6.5 *Filter thickness.* 30 to 50 µm.

6.6 *Maximum pressure drop (clean filter).* 30 cm H_2O column @ 16.67 L/min clean air flow.

6.7 *Maximum moisture pickup.* Not more than 10 µg weight increase after 24-hour exposure to air of 40 percent relative humidity, relative to weight after 24-hour exposure to air of 35 percent relative humidity.

6.8 *Collection efficiency.* Greater than 99.7 percent, as measured by the DOP test (ASTM D 2986–91) with 0.3 µm particles at the sampler's operating face velocity.

6.9 *Filter weight stability.* Filter weight loss shall be less than 20 µg, as measured in each of the following two tests specified in sections 6.9.1 and 6.9.2 of this appendix. The following conditions apply to both of these tests: Filter weight loss shall be the average difference between the initial and the final filter weights of a random sample of test filters selected from each lot prior to sale. The number of filters tested shall be not less than 0.1 percent of the filters of each manufacturing lot, or 10 filters, whichever is greater. The filters shall be weighed under laboratory conditions and shall have had no air sample passed through them, i.e., filter blanks. Each test procedure must include initial conditioning and weighing, the test, and final conditioning and weighing. Conditioning and weighing shall be in accordance with sections 8.0 through 8.2 of this appendix and general guidance provided in reference 2 of section 13.0 of this appendix.

6.9.1 *Test for loose, surface particle contamination.* After the initial weighing, install each test filter, in turn, in a filter cassette (Figures L–27, L–28, and L–29 of this appendix) and drop the cassette from a height of 25 cm to a flat hard surface, such as a particle-free wood bench. Repeat two times, for a total of three drop tests for each test filter. Remove the test filter from the cassette and weigh the filter. The average change in weight must be less than 20 µg.

6.9.2 *Test for temperature stability.* After weighing each filter, place the test filters in a drying oven set at 40 °C ±2 °C for not less than 48 hours. Remove, condition, and reweigh each test filter. The average change in weight must be less than 20 µg.

6.10 *Alkalinity.* Less than 25 microequivalents/gram of filter, as measured by the guidance given in reference 2 in section 13.0 of this appendix.

6.11 *Supplemental requirements.* Although not required for determination of $PM_{2.5}$ mass concentration under this reference method, additional specifications for the filter must be developed by users who intend to subject $PM_{2.5}$ filter samples to subsequent chemical analysis. These supplemental specifications include background chemical contamination of the filter and any other filter parameters that may be required by the method of chemical analysis. All such supplemental filter specifications must be compatible with and secondary to the primary filter specifications given in this section 6.0 of this appendix.

7.0 *$PM_{2.5}$ Sampler.*

7.1 *Configuration.* The sampler shall consist of a sample air inlet, downtube, particle size separator (impactor), filter holder assembly, air pump and flow rate control system, flow rate measurement device, ambient and filter temperature monitoring system, barometric pressure measurement system, timer, outdoor environmental enclosure, and suitable mechanical, electrical, or electronic control capability to meet or exceed the design and functional performance as specified in this section 7.0 of this appendix. The performance specifications require that the sampler:

(a) Provide automatic control of sample volumetric flow rate and other operational parameters.

(b) Monitor these operational parameters as well as ambient temperature and pressure.

(c) Provide this information to the sampler operator at the end of each sample period in digital form, as specified in Table L–1 of section 7.4.19 of this appendix.

7.2 *Nature of specifications.* The $PM_{2.5}$ sampler is specified by a combination of design and performance requirements. The sample inlet, downtube, particle size discriminator, filter cassette, and the internal configuration of the filter holder assembly are specified explicitly by design figures and associated mechanical dimensions, tolerances, materials, surface finishes, assembly instructions, and other necessary specifications. All other aspects of the sampler are specified by required operational function and performance, and the design of these other aspects (including the design of the lower portion of the filter holder assembly) is optional, subject to acceptable operational performance. Test procedures to demonstrate compliance with both the design and performance requirements are set forth in subpart E of part 53 of this chapter.

7.3 *Design specifications.* Except as indicated in this section 7.3 of this appendix, these components must be manufactured or reproduced exactly as specified, in an ISO 9001-registered facility, with registration initially approved and subsequently maintained during the period of manufacture. See § 53.1(t) of this chapter for the definition of an ISO-registered facility. Minor modifications or variances to one or more components that clearly would not affect the aerodynamic performance of the inlet, downtube, impactor, or filter cassette will be considered for specific approval. Any such proposed modifications shall be described and submitted to the EPA for specific individual acceptability either as part of a reference or equivalent method application under part 53 of this chapter or in writing in advance of such an intended application under part 53 of this chapter.

7.3.1 *Sample inlet assembly.* The sample inlet assembly, consisting of the inlet, downtube, and impactor shall be configured and assembled as indicated in Figure L–1 of this appendix and shall meet all associated requirements. A portion of this assembly shall also be subject to the maximum overall sampler leak rate specification under section 7.4.6 of this appendix.

7.3.2 *Inlet.* The sample inlet shall be fabricated as indicated in Figures L–2 through L–18 of this appendix and shall meet all associated requirements.

7.3.3 *Downtube.* The downtube shall be fabricated as indicated in Figure L–19 of this appendix and shall meet all associated requirements.

7.3.4 *Impactor.*

7.3.4.1 The impactor (particle size separator) shall be fabricated as indicated in Figures L–20 through L–24 of this appendix and shall meet all associated requirements. Following the manufacture and finishing of each upper impactor housing (Figure L–21 of this appendix), the dimension of the impaction jet must be verified by the manufacturer using Class ZZ go/no-go plug gauges that are traceable to NIST.

7.3.4.2 Impactor filter specifications:

(a) Size. Circular, 35 to 37 mm diameter.

(b) Medium. Borosilicate glass fiber, without binder.

(c) Pore size. 1 to 1.5 micrometer, as measured by ASTM F 316–80.

(d) Thickness. 300 to 500 micrometers.

7.3.4.3 Impactor oil specifications:

(a) Composition. Tetramethyltetraphenyltrisiloxane, single-compound diffusion oil.

(b) Vapor pressure. Maximum 2 x 10^{-8} mm Hg at 25 °C.

(c) Viscosity. 36 to 40 centistokes at 25 °C.

(d) Density. 1.06 to 1.07 g/cm³ at 25 °C.

(e) Quantity. 1 mL ±0.1 mL.

7.3.5 *Filter holder assembly.* The sampler shall have a sample filter holder assembly to adapt and seal to the down tube and to hold and seal the specified filter, under section 6.0 of this appendix, in the sample air stream in a horizontal position below the downtube such that the sample air passes downward through the filter at a uniform face velocity. The upper portion of this assembly shall be fabricated as indicated in Figures L–25 and L–26 of this appendix and shall accept and seal with the filter cassette, which shall be fabricated as indicated in Figures L–27 through L–29 of this appendix.

(a) The lower portion of the filter holder assembly shall be of a design and construction that:

(1) Mates with the upper portion of the assembly to complete the filter holder assembly,

(2) Completes both the external air seal and the internal filter cassette seal such that all seals are reliable over repeated filter changings, and

(3) Facilitates repeated changing of the filter cassette by the sampler operator.

(b) Leak–test performance requirements for the filter holder assembly are included in section 7.4.6 of this appendix.

(c) If additional or multiple filters are stored in the sampler as part of an automatic sequential sample capability, all such filters, unless they are currently and directly installed in a sampling channel or sampling configuration (either active or inactive), shall be covered or (preferably) sealed in such a way as to:

(1) Preclude significant exposure of the filter to possible contamination or accumulation of dust, insects, or other material that may be present in the ambient air, sampler, or sampler ventilation air during storage periods either before or after sampling; and

(2) To minimize loss of volatile or semi-volatile PM sample components during storage of the filter following the sample period.

7.3.6 *Flow rate measurement adapter.* A flow rate measurement adapter as specified in Figure L–30 of this appendix shall be furnished with each sampler.

7.3.7 *Surface finish.* All internal surfaces exposed to sample air prior to the filter shall be treated electrolytically in a sulfuric acid bath to produce a clear, uniform anodized surface finish of not less than 1000 mg/ft² (1.08 mg/cm²) in accordance with military standard specification (mil. spec.) 8625F, Type II, Class 1 in reference 4 of section 13.0 of this appendix. This anodic surface coating shall not be dyed or pigmented. Following anodization, the surfaces shall be sealed by immersion in boiling deionized water for not less than 15 minutes. Section 53.51(d)(2) of this chapter should also be consulted.

7.3.8 *Sampling height.* The sampler shall be equipped with legs, a stand, or other means to maintain the sampler in a stable, upright position and such that the center of the sample air entrance to the inlet, during sample collection, is maintained in a horizontal plane and is 2.0 ±0.2 meters above the floor or other horizontal supporting surface. Suitable bolt holes, brackets, tie-downs, or other means should be provided to facilitate mechanically securing the sample to the supporting surface to prevent toppling of the sampler due to wind.

7.4 *Performance specifications.*

7.4.1 *Sample flow rate.* Proper operation of the impactor requires that specific air velocities be maintained through the device. Therefore, the design sample air flow rate through the inlet shall be 16.67 L/min (1.000 m³/hour) measured as actual volumetric flow rate at the temperature and pressure of the sample air entering the inlet.

7.4.2 *Sample air flow rate control system.* The sampler shall have a sample air flow rate control system which shall be capable of providing a sample air volumetric flow rate within the specified range, under section 7.4.1 of this appendix, for the specified filter, under section 6.0 of this appendix, at any atmospheric conditions specified, under section 7.4.7 of this appendix, at a filter pressure drop equal to that of a clean filter plus up to 75 cm water column (55 mm Hg), and over the specified range of supply line voltage, under section 7.4.15.1 of this appendix. This flow control system shall allow for operator adjustment of the operational flow rate of the sampler over a range of at least ±15 percent of the flow rate specified in section 7.4.1 of this appendix.

7.4.3 *Sample flow rate regulation.* The sample flow rate shall be regulated such that for the specified filter, under section 6.0 of this appendix, at any atmospheric conditions specified, under section 7.4.7 of this appendix, at a filter pressure drop equal to that of a clean filter plus up to 75 cm water column (55 mm Hg), and over the specified range of supply line voltage, under section 7.4.15.1 of this appendix, the flow rate is regulated as follows:

7.4.3.1 The volumetric flow rate, measured or averaged over intervals of not more than 5 minutes over a 24-hour period, shall not vary more than ±5 percent from the specified 16.67 L/min flow rate over the entire sample period.

7.4.3.2 The coefficient of variation (sample standard deviation divided by the mean) of the flow rate, measured over a 24-hour period, shall not be greater than 2 percent.

7.4.3.3 The amplitude of short-term flow rate pulsations, such as may originate from some types of vacuum pumps, shall be attenuated such that they do not cause significant flow measurement error or affect the collection of particles on the particle collection filter.

7.4.4 *Flow rate cut off.* The sampler's sample air flow rate control system shall terminate sample collection and stop all sample flow for the remainder of the sample period in the event that the sample flow rate deviates by more than 10 percent from the sampler design flow rate specified in section 7.4.1 of this appendix for more than 60 seconds. However, this sampler cut-off provision shall not apply during periods when the sampler is inoperative due to a temporary power interruption, and the elapsed time of the inoperative period shall not be included in the total sample time measured and reported by the sampler, under section 7.4.13 of this appendix.

7.4.5 *Flow rate measurement.*

7.4.5.1 The sampler shall provide a means to measure and indicate the instantaneous sample air flow rate, which shall be measured as volumetric flow rate at the temperature and pressure of the sample air entering the inlet, with an accuracy of ±2 percent. The measured flow rate shall be available for display to the sampler operator at any time in either sampling or standby modes, and the measurement shall be updated at least every 30 seconds. The sampler shall also provide a simple means by which the sampler operator can manually start the sample flow temporarily during non-sampling modes of operation, for the purpose of checking the sample flow rate or the flow rate measurement system.

7.4.5.2 During each sample period, the sampler's flow rate measurement system shall automatically monitor the sample volumetric flow rate, obtaining flow rate measurements at intervals of not greater than 30 seconds.

(a) Using these interval flow rate measurements, the sampler shall determine or calculate the following flow-related parameters, scaled in the specified engineering units:

(1) The instantaneous or interval-average flow rate, in L/min.

(2) The value of the average sample flow rate for the sample period, in L/min.

(3) The value of the coefficient of variation (sample standard deviation divided by the average) of the sample flow rate for the sample period, in percent.

(4) The occurrence of any time interval during the sample period in which the measured sample flow rate exceeds a range of ±5 percent of the average flow rate for the sample period for more than 5 minutes, in which case a warning flag indicator shall be set.

(5) The value of the integrated total sample volume for the sample period, in m^3.

(b) Determination or calculation of these values shall properly exclude periods when the sampler is inoperative due to temporary interruption of electrical power, under section 7.4.13 of this appendix, or flow rate cut off, under section 7.4.4 of this appendix.

(c) These parameters shall be accessible to the sampler operator as specified in Table L–1 of section 7.4.19 of this appendix. In addition, it is strongly encouraged that the flow rate for each 5-minute interval during the sample period be available to the operator following the end of the sample period.

7.4.6 *Leak test capability.*

7.4.6.1 *External leakage.* The sampler shall include an external air leak-test capability consisting of components, accessory hardware, operator interface controls, a written procedure in the associated Operation/Instruction Manual, under section 7.4.18 of this appendix, and all other necessary functional capability to permit and facilitate the sampler operator to conveniently carry out a leak test of the sampler at a field monitoring site without additional equipment. The sampler components to be subjected to this leak test include all components and their interconnections in which external air leakage would or could cause an error in the sampler's measurement of the total volume of sample air that passes through the sample filter.

(a) The suggested technique for the operator to use for this leak test is as follows:

(1) Remove the sampler inlet and installs the flow rate measurement adapter supplied with the sampler, under section 7.3.6 of this appendix.

(2) Close the valve on the flow rate measurement adapter and use the sampler air pump to draw a partial vacuum in the sampler, including (at least) the impactor, filter holder assembly (filter in place), flow measurement device, and interconnections between these devices, of at least 55 mm Hg (75 cm water column), measured at a location downstream of the filter holder assembly.

(3) Plug the flow system downstream of these components to isolate the components under vacuum from the pump, such as with a built-in valve.

(4) Stop the pump.

(5) Measure the trapped vacuum in the sampler with a built-in pressure measuring device.

(6) (i) Measure the vacuum in the sampler with the built-in pressure measuring device again at a later time at least 10 minutes after the first pressure measurement.

(ii) **Caution:** Following completion of the test, the adaptor valve should be opened slowly to limit the flow rate of air into the sampler. Excessive air flow rate may blow oil out of the impactor.

(7) Upon completion of the test, open the adaptor valve, remove the adaptor and plugs, and restore the sampler to the normal operating configuration.

(b) The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.

(c) Variations of the suggested technique or an alternative external leak test technique may be required for samplers whose design or configuration would make the suggested technique impossible or impractical. The specific proposed external leak test procedure, or particularly an alternative leak test technique, proposed for a particular candidate sampler may be described and submitted to the EPA for specific individual acceptability either as part of a reference or equivalent method application under part 53 of this chapter or in writing in advance of such an intended application under part 53 of this chapter.

7.4.6.2 *Internal, filter bypass leakage.* The sampler shall include an internal, filter bypass leak-check capability consisting of components, accessory hardware, operator interface controls, a written procedure in the Operation/Instruction Manual, and all other necessary functional capability to permit and facilitate the sampler operator to conveniently carry out a test for internal filter bypass leakage in the sampler at a field monitoring site without additional equipment. The purpose of the test is to determine that any portion of the sample flow rate that leaks past the sample filter without passing through the filter is insignificant relative to the design flow rate for the sampler.

(a) The suggested technique for the operator to use for this leak test is as follows:

(1) Carry out an external leak test as provided under section 7.4.6.1 of this appendix which indicates successful passage of the prescribed external leak test.

(2) Install a flow-impervious membrane material in the filter cassette, either with or without a filter, as appropriate, which effectively prevents air flow through the filter.

(3) Use the sampler air pump to draw a partial vacuum in the sampler, downstream of the filter holder assembly, of at least 55 mm Hg (75 cm water column).

(4) Plug the flow system downstream of the filter holder to isolate the components under vacuum from the pump, such as with a built-in valve.

(5) Stop the pump.

(6) Measure the trapped vacuum in the sampler with a built-in pressure measuring device.

(7) Measure the vacuum in the sampler with the built-in pressure measuring device again at a later time at least 10 minutes after the first pressure measurement.

(8) Remove the flow plug and membrane and restore the sampler to the normal operating configuration.

(b) The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the portion of the sampler under vacuum, that indicates a leak of less than 80 mL/min.

(c) Variations of the suggested technique or an alternative internal, filter bypass leak test technique may be required for samplers whose design or configuration would make the suggested technique impossible or impractical. The specific proposed internal leak test procedure, or particularly an alternative internal leak test technique proposed for a particular candidate sampler may be described and submitted to the EPA for specific individual acceptability either as part of a reference or equivalent method application under part 53 of this chapter or in writing in advance of such intended application under part 53 of this chapter.

7.3.5 *Filter holder assembly.* The sampler shall have a sample filter holder assembly to adapt and seal to the down tube and to hold and seal the specified filter, under section 6.0 of this appendix, in the sample air stream in a horizontal position below the downtube such that the sample air passes downward through the filter at a uniform face velocity. The upper portion of this assembly shall be fabricated as indicated in Figures L–25 and L–26 of this appendix and shall accept and seal with the filter cassette, which shall be fabricated as indicated in Figures L–27 through L–29 of this appendix.

(a) The lower portion of the filter holder assembly shall be of a design and construction that:

(1) Mates with the upper portion of the assembly to complete the filter holder assembly,

(2) Completes both the external air seal and the internal filter cassette seal such that all seals are reliable over repeated filter changings, and

(3) Facilitates repeated changing of the filter cassette by the sampler operator.

(b) Leak–test performance requirements for the filter holder assembly are included in section 7.4.6 of this appendix.

(c) If additional or multiple filters are stored in the sampler as part of an automatic sequential sample capability, all such filters, unless they are currently and directly installed in a sampling channel or sampling configuration (either active or inactive), shall be covered or (preferably) sealed in such a way as to:

(1) Preclude significant exposure of the filter to possible contamination or accumulation of dust, insects, or other material that may be present in the ambient air, sampler, or sampler ventilation air during storage periods either before or after sampling; and

(2) To minimize loss of volatile or semi-volatile PM sample components during storage of the filter following the sample period.

7.3.6 *Flow rate measurement adapter.* A flow rate measurement adapter as specified in Figure L–30 of this appendix shall be furnished with each sampler.

7.3.7 *Surface finish.* All internal surfaces exposed to sample air prior to the filter shall be treated electrolytically in a sulfuric acid bath to produce a clear, uniform anodized surface finish of not less than 1000 mg/ft^2 (1.08 mg/cm^2) in accordance with military standard specification (mil. spec.) 8625F, Type II, Class 1 in reference 4 of section 13.0 of this appendix. This anodic surface coating shall not be dyed or pigmented. Following anodization, the surfaces shall be sealed by immersion in boiling deionized water for not less than 15 minutes. Section 53.51(d)(2) of this chapter should also be consulted.

7.3.8 *Sampling height.* The sampler shall be equipped with legs, a stand, or other means to maintain the sampler in a stable, upright position and such that the center of the sample air entrance to the inlet, during sample collection, is maintained in a horizontal plane and is 2.0 ±0.2 meters above the floor or other horizontal supporting surface. Suitable bolt holes, brackets, tie-downs, or other means should be provided to facilitate mechanically securing the sample to the supporting surface to prevent toppling of the sampler due to wind.

7.4 *Performance specifications.*

7.4.1 *Sample flow rate.* Proper operation of the impactor requires that specific air velocities be maintained through the device. Therefore, the design sample air flow rate through the inlet shall be 16.67 L/min (1.000 m^3/hour) measured as actual volumetric flow rate at the temperature and pressure of the sample air entering the inlet.

7.4.2 *Sample air flow rate control system.* The sampler shall have a sample air flow rate control system which shall be capable of providing a sample air volumetric flow rate within the specified range, under section 7.4.1 of this appendix, for the specified filter, under section 6.0 of this appendix, at any atmospheric conditions specified, under section 7.4.7 of this appendix, at a filter pressure drop equal to that of a clean filter plus up to 75 cm water column (55 mm Hg), and over the specified range of supply line voltage, under section 7.4.15.1 of this appendix. This flow control system shall allow for operator adjustment of the operational flow rate of the sampler over a range of at least ±15 percent of the flow rate specified in section 7.4.1 of this appendix.

7.4.3 *Sample flow rate regulation.* The sample flow rate shall be regulated such that for the specified filter, under section 6.0 of this appendix, at any atmospheric conditions specified, under section 7.4.7 of this appendix, at a filter pressure drop equal to that of a clean filter plus up to 75 cm water column (55 mm Hg), and over the specified range of supply line voltage, under section 7.4.15.1 of this appendix, the flow rate is regulated as follows:

7.4.3.1 The volumetric flow rate, measured or averaged over intervals of not more than 5 minutes over a 24-hour period, shall not vary more than ±5 percent from the specified 16.67 L/min flow rate over the entire sample period.

7.4.3.2 The coefficient of variation (sample standard deviation divided by the mean) of the flow rate, measured over a 24-hour period, shall not be greater than 2 percent.

7.4.3.3 The amplitude of short-term flow rate pulsations, such as may originate from some types of vacuum pumps, shall be attenuated such that they do not cause significant flow measurement error or affect the collection of particles on the particle collection filter.

7.4.4 *Flow rate cut off.* The sampler's sample air flow rate control system shall terminate sample collection and stop all sample flow for the remainder of the sample period in the event that the sample flow rate deviates by more than 10 percent from the sampler design flow rate specified in section 7.4.1 of this appendix for more than 60 seconds. However, this sampler cut-off provision shall not apply during periods when the sampler is inoperative due to a temporary power interruption, and the elapsed time of the inoperative period shall not be included in the total sample time measured and reported by the sampler, under section 7.4.13 of this appendix.

7.4.5 *Flow rate measurement.*

7.4.5.1 The sampler shall provide a means to measure and indicate the instantaneous sample air flow rate, which shall be measured as volumetric flow rate at the temperature and pressure of the sample air entering the inlet, with an accuracy of ±2 percent. The measured flow rate shall be available for display to the sampler operator at any time in either sampling or standby modes, and the measurement shall be updated at least every 30 seconds. The sampler shall also provide a simple means by which the sampler operator can manually start the sample flow temporarily during non-sampling modes of operation, for the purpose of checking the sample flow rate or the flow rate measurement system.

7.4.5.2 During each sample period, the sampler's flow rate measurement system shall automatically monitor the sample volumetric flow rate, obtaining flow rate measurements at intervals of not greater than 30 seconds.

(a) Using these interval flow rate measurements, the sampler shall determine or calculate the following flow-related parameters, scaled in the specified engineering units:

(1) The instantaneous or interval-average flow rate, in L/min.

(2) The value of the average sample flow rate for the sample period, in L/min.

(3) The value of the coefficient of variation (sample standard deviation divided by the average) of the sample flow rate for the sample period, in percent.

(4) The occurrence of any time interval during the sample period in which the measured sample flow rate exceeds a range of ±5 percent of the average flow rate for the sample period for more than 5 minutes, in which case a warning flag indicator shall be set.

(5) The value of the integrated total sample volume for the sample period, in m^3.

(b) Determination or calculation of these values shall properly exclude periods when the sampler is inoperative due to temporary interruption of electrical power, under section 7.4.13 of this appendix, or flow rate cut off, under section 7.4.4 of this appendix.

(c) These parameters shall be accessible to the sampler operator as specified in Table L–1 of section 7.4.19 of this appendix. In addition, it is strongly encouraged that the flow rate for each 5-minute interval during the sample period be available to the operator following the end of the sample period.

7.4.6 *Leak test capability.*

7.4.6.1 *External leakage.* The sampler shall include an external air leak-test capability consisting of components, accessory hardware, operator interface controls, a written procedure in the associated Operation/Instruction Manual, under section 7.4.18 of this appendix, and all other necessary functional capability to permit and facilitate the sampler operator to conveniently carry out a leak test of the sampler at a field monitoring site without additional equipment. The sampler components to be subjected to this leak test include all components and their interconnections in which external air leakage would or could cause an error in the sampler's measurement of the total volume of sample air that passes through the sample filter.

(a) The suggested technique for the operator to use for this leak test is as follows:

(1) Remove the sampler inlet and installs the flow rate measurement adapter supplied with the sampler, under section 7.3.6 of this appendix.

(2) Close the valve on the flow rate measurement adapter and use the sampler air pump to draw a partial vacuum in the sampler, including (at least) the impactor, filter holder assembly (filter in place), flow measurement device, and interconnections between these devices, of at least 55 mm Hg (75 cm water column), measured at a location downstream of the filter holder assembly.

(3) Plug the flow system downstream of these components to isolate the components under vacuum from the pump, such as with a built-in valve.

(4) Stop the pump.

(5) Measure the trapped vacuum in the sampler with a built-in pressure measuring device.

(6) (i) Measure the vacuum in the sampler with the built-in pressure measuring device again at a

later time at least 10 minutes after the first pressure measurement.

(ii) **Caution:** Following completion of the test, the adaptor valve should be opened slowly to limit the flow rate of air into the sampler. Excessive air flow rate may blow oil out of the impactor.

(7) Upon completion of the test, open the adaptor valve, remove the adaptor and plugs, and restore the sampler to the normal operating configuration.

(b) The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the sampler, that indicates a leak of less than 80 mL/min.

(c) Variations of the suggested technique or an alternative external leak test technique may be required for samplers whose design or configuration would make the suggested technique impossible or impractical. The specific proposed external leak test procedure, or particularly an alternative leak test technique, proposed for a particular candidate sampler may be described and submitted to the EPA for specific individual acceptability either as part of a reference or equivalent method application under part 53 of this chapter or in writing in advance of such an intended application under part 53 of this chapter.

7.4.6.2 *Internal, filter bypass leakage.* The sampler shall include an internal, filter bypass leak-check capability consisting of components, accessory hardware, operator interface controls, a written procedure in the Operation/Instruction Manual, and all other necessary functional capability to permit and facilitate the sampler operator to conveniently carry out a test for internal filter bypass leakage in the sampler at a field monitoring site without additional equipment. The purpose of the test is to determine that any portion of the sample flow rate that leaks past the sample filter without passing through the filter is insignificant relative to the design flow rate for the sampler.

(a) The suggested technique for the operator to use for this leak test is as follows:

(1) Carry out an external leak test as provided under section 7.4.6.1 of this appendix which indicates successful passage of the prescribed external leak test.

(2) Install a flow-impervious membrane material in the filter cassette, either with or without a filter, as appropriate, which effectively prevents air flow through the filter.

(3) Use the sampler air pump to draw a partial vacuum in the sampler, downstream of the filter holder assembly, of at least 55 mm Hg (75 cm water column).

(4) Plug the flow system downstream of the filter holder to isolate the components under vacuum from the pump, such as with a built-in valve.

(5) Stop the pump.

(6) Measure the trapped vacuum in the sampler with a built-in pressure measuring device.

(7) Measure the vacuum in the sampler with the built-in pressure measuring device again at a later time at least 10 minutes after the first pressure measurement.

(8) Remove the flow plug and membrane and restore the sampler to the normal operating configuration.

(b) The associated leak test procedure shall require that for successful passage of this test, the difference between the two pressure measurements shall not be greater than the number of mm of Hg specified for the sampler by the manufacturer, based on the actual internal volume of the portion of the sampler under vacuum, that indicates a leak of less than 80 mL/min.

(c) Variations of the suggested technique or an alternative internal, filter bypass leak test technique may be required for samplers whose design or configuration would make the suggested technique impossible or impractical. The specific proposed internal leak test procedure, or particularly an alternative internal leak test technique proposed for a particular candidate sampler may be described and submitted to the EPA for specific individual acceptability either as part of a reference or equivalent method application under part 53 of this chapter or in writing in advance of such intended application under part 53 of this chapter.

7.4.7 *Range of operational conditions.* The sampler is required to operate properly and meet all requirements specified in this appendix over the following operational ranges.

7.4.7.1 *Ambient temperature.* -30 to +45 °C (Note: Although for practical reasons, the temperature range over which samplers are required to be tested under part 53 of this chapter is -20 to +40 °C, the sampler shall be designed to operate properly over this wider temperature range.).

7.4.7.2 *Ambient relative humidity.* 0 to 100 percent.

7.4.7.3 *Barometric pressure range.* 600 to 800 mm Hg.

7.4.8 *Ambient temperature sensor.* The sampler shall have capability to measure the temperature of the ambient air surrounding the sampler over the range of -30 to +45 °C, with a resolution of 0.1 °C and accuracy of ±2.0 °C, referenced as described in reference 3 in section 13.0 of this appendix, with and without maximum solar insolation.

7.4.8.1 The ambient temperature sensor shall be mounted external to the sampler enclosure and shall have a passive, naturally ventilated sun shield. The sensor shall be located such that the entire sun shield is at least 5 cm above the horizontal plane of the sampler case or enclosure (disregarding the inlet and downtube) and external to the vertical plane of the nearest side or protuberance of the sampler case or enclosure. The maximum temperature measurement error of the ambient temperature measurement system shall be less than 1.6 °C at 1 m/s wind speed and 1000 W/m2 solar radiation intensity.

7.4.8.2 The ambient temperature sensor shall be of such a design and mounted in such a way as to facilitate its convenient dismounting and immersion in a liquid for calibration and comparison to the filter temperature sensor, under section 7.4.11 of this appendix.

7.4.8.3 This ambient temperature measurement shall be updated at least every 30 seconds during both sampling and standby (non-sampling) modes of operation. A visual indication of the current (most recent) value of the ambient temperature measurement, updated at least every 30 seconds, shall be available to the sampler operator during both sampling and standby (non-sampling) modes of operation, as specified in Table L–1 of section 7.4.19 of this appendix.

7.4.8.4 This ambient temperature measurement shall be used for the purpose of monitoring filter temperature deviation from ambient temperature, as required by section 7.4.11 of this appendix, and may be used for purposes of effecting filter temperature control, under section 7.4.10 of this appendix, or computation of volumetric flow rate, under sections 7.4.1 to 7.4.5 of this appendix, if appropriate.

7.4.8.5 Following the end of each sample period, the sampler shall report the maximum, minimum, and average temperature for the sample period, as specified in Table L–1 of section 7.4.19 of this appendix.

7.4.9 *Ambient barometric sensor.* The sampler shall have capability to measure the barometric pressure of the air surrounding the sampler over a range of 600 to 800 mm Hg referenced as described in reference 3 in section 13.0 of this appendix; also see part 53, subpart E of this chapter. This barometric pressure measurement shall have a resolution of 5 mm Hg and an accuracy of ±10 mm Hg and shall be updated at least every 30 seconds. A visual indication of the value of the current (most recent) barometric pressure measurement, updated at least every 30 seconds, shall be available to the sampler operator during both sampling and standby (non-sampling) modes of operation, as specified in Table L–1 of section 7.4.19 of this appendix. This barometric pressure measurement may be used for purposes of computation of volumetric flow rate, under sections 7.4.1 to 7.4.5 of this appendix, if appropriate. Following the end of a sample period, the sampler shall report the maximum, minimum, and mean barometric pressures for the sample period, as specified in Table L–1 of section 7.4.19 of this appendix.

7.4.10 *Filter temperature control (sampling and post-sampling).* The sampler shall provide a means to limit the temperature rise of the sample filter (all sample filters for sequential samplers), from insolation and other sources, to no more 5 °C above the temperature of the ambient air surrounding the sampler, during both sampling and post-sampling periods of operation. The post-sampling period is the non-sampling period between the end of the active sampling period and the time of retrieval of the sample filter by the sampler operator.

7.4.11 *Filter temperature sensor(s).*

7.4.11.1 The sampler shall have the capability to monitor the temperature of the sample filter (all sample filters for sequential samplers) over the range of -30 to +45 °C during both sampling and non-sampling periods. While the exact location of this temperature sensor is not explicitly specified, the filter temperature measurement system must demonstrate agreement, within 1 °C, with a test temperature sensor located within 1 cm of the center of the filter downstream of the filter during both sampling and non-sampling modes, as specified in the filter temperature measurement test described in part 53, subpart E of this chapter. This filter temperature measurement shall have a resolution of 0.1 °C and accuracy of ±1.0 °C, referenced as described in reference 3 in section 13.0 of this appendix. This temperature sensor shall be of such a design and mounted in such a way as to facilitate its reasonably convenient dismounting and immersion in a liquid for calibration and comparison to the ambient temperature sensor under section 7.4.8 of this appendix.

7.4.11.2 The filter temperature measurement shall be updated at least every 30 seconds during both sampling and standby (non-sampling) modes of operation. A visual indication of the current (most recent) value of the filter temperature measurement, updated at least every 30 seconds, shall be available to the sampler operator during both sampling and standby (non-sampling) modes of operation, as specified in Table L–1 of section 7.4.19 of this appendix.

7.4.11.3 For sequential samplers, the temperature of each filter shall be measured individually unless it can be shown, as specified in the filter temperature measurement test described in § 53.57 of this chapter, that the temperature of each filter can be represented by fewer temperature sensors.

7.4.11.4 The sampler shall also provide a warning flag indicator following any occurrence in which the filter temperature (any filter temperature for sequential samplers) exceeds the ambient temperature by more than 5 °C for more than 30 consecutive minutes during either the sampling or post-sampling periods of operation, as specified in Table L–1 of section 7.4.19 of this appendix, under section 10.12 of this appendix, regarding sample validity when a warning flag occurs. It is further recommended (not required) that the sampler be capable of recording the maximum differential between the measured filter temperature and the ambient temperature and its time and date of occurrence during both sampling and post-sampling (non-sampling) modes of operation and providing for those data to be accessible to the sampler operator following the end of the sample period, as suggested in Table L–1 of section 7.4.19 of this appendix.

7.4.12 *Clock/timer system.*

(a) The sampler shall have a programmable real-time clock timing/control system that:

(1) Is capable of maintaining local time and date, including year, month, day-of-month, hour, minute, and second to an accuracy of ±1.0 minute per month.

(2) Provides a visual indication of the current system time, including year, month, day-of-month, hour, and minute, updated at least each minute, for operator verification.

(3) Provides appropriate operator controls for setting the correct local time and date.

(4) Is capable of starting the sample collection period and sample air flow at a specific, operator-settable time and date, and stopping the sample air flow and terminating the sampler collection period 24 hours (1440 minutes) later, or at a specific, operator-settable time and date.

(b) These start and stop times shall be readily settable by the sampler operator to within ±1.0 minute. The system shall provide a visual indication of the current start and stop time settings, readable to ±1.0 minute, for verification by the operator, and the start and stop times shall also be available via the data output port, as specified in Table L–1 of section 7.4.19 of this appendix. Upon execution of a programmed sample period start, the sampler shall automatically reset all sample period information and warning flag indications pertaining to a previous sample period. Refer also to section 7.4.15.4 of this appendix regarding retention of current date and time and programmed start and stop times during a temporary electrical power interruption.

7.4.13 *Sample time determination.* The sampler shall be capable of determining the elapsed sample collection time for each $PM_{2.5}$ sample, accurate to within ±1.0 minute, measured as the time between the start of the sampling period, under section 7.4.12 of this appendix and the termination of the sample period, under section 7.4.12 of this appendix or section 7.4.4 of this appendix. This elapsed sample time shall not include periods when the sampler is inoperative due to a temporary interruption of electrical power, under section 7.4.15.4 of this appendix. In the event that the elapsed sample time determined for the sample period is not within the range specified for the required sample period in section 3.3 of this appendix, the sampler shall set a warning flag indicator. The date and time of the start of the sample period, the value of the elapsed sample time for the sample period, and the flag indicator status shall be available to the sampler operator following the end of the sample period, as specified in Table L–1 of section 7.4.19 of this appendix.

7.4.14 *Outdoor environmental enclosure.* The sampler shall have an outdoor enclosure (or enclosures) suitable to protect the filter and other non-weatherproof components of the sampler from precipitation, wind, dust, extremes of temperature and humidity; to help maintain temperature control of the filter (or filters, for sequential samplers); and to provide reasonable security for sampler components and settings.

7.4.15 *Electrical power supply.*

7.4.15.1 The sampler shall be operable and function as specified herein when operated on an electrical power supply voltage of 105 to 125 volts AC (RMS) at a frequency of 59 to 61 Hz. Optional operation as specified at additional power supply voltages and/or frequencies shall not be precluded by this requirement.

7.4.15.2 The design and construction of the sampler shall comply with all applicable National Electrical Code and Underwriters Laboratories electrical safety requirements.

7.4.15.3 The design of all electrical and electronic controls shall be such as to provide reasonable resistance to interference or malfunction from ordinary or typical levels of stray electromagnetic fields (EMF) as may be found at various monitoring sites and from typical levels of electrical transients or electronic noise as may often or occasionally be present on various electrical power lines.

7.4.15.4 In the event of temporary loss of electrical supply power to the sampler, the sampler shall not be required to sample or provide other specified functions during such loss of power, except that the internal clock/timer system shall maintain its local time and date setting within ±1 minute per week, and the sampler shall retain all other time and programmable settings and all data required to be available to the sampler operator following each sample period for at least 7 days without electrical supply power. When electrical power is absent at the operator-set time for starting a sample period or is interrupted during a sample period, the sampler shall automatically start or resume sampling when electrical power is restored, if such restoration of power occurs before the operator-set stop time for the sample period.

7.4.15.5 The sampler shall have the capability to record and retain a record of the year, month, day-of-month, hour, and minute of the start of each power interruption of more than 1 minute duration, up to 10 such power interruptions per sample period. (More than 10 such power interruptions shall invalidate the sample, except where an exceedance is measured, under section 3.3 of this appendix.) The sampler shall provide for these power interruption data to be available to the sampler operator following the end of the sample period, as specified in Table L–1 of section 7.4.19 of this appendix.

7.4.16 *Control devices and operator interface.* The sampler shall have mechanical, electrical, or electronic controls, control devices, electrical or electronic circuits as necessary to provide the timing, flow rate measurement and control, temperature control, data storage and computation, operator interface, and other functions specified. Operator-accessible controls, data displays, and interface devices shall be designed to be simple, straightforward, reliable, and easy to learn, read, and operate under field conditions. The sampler shall have provision for operator input and storage of up to 64 characters of numeric (or alphanumeric) data for purposes of site, sampler, and sample identification. This information shall be available to the sampler operator for verification and change and for output via the data output port along with other data following the end of a sample period, as specified in Table L–1 of section 7.4.19 of this appendix. All data required to be available to the operator following a sample collection period or obtained during standby mode in a post-sampling period shall be retained by the sampler until reset, either manually by the operator or automatically by the sampler upon initiation of a new sample collection period.

7.4.17 *Data output port requirement.* The sampler shall have a standard RS–232C data output connection through which digital data may be exported to an external data storage or transmission device. All information which is required to be available at the end of each sample period shall be accessible through this data output connection. The information that shall be accessible though this output port is summarized in Table L–1 of section 7.4.19 of this appendix. Since no specific format for the output data is provided, the sampler manufacturer or vendor shall make available to sampler purchasers appropriate computer software capable of receiving exported sampler data and correctly translating the data into a standard spreadsheet format and optionally any other formats as may be useful to sampler users. This requirement shall not preclude the sampler from offering other types of output connections in addition to the required RS–232C port.

7.4.18 *Operation/instruction manual.* The sampler shall include an associated comprehensive operation or instruction manual, as required by part 53 of this chapter, which includes detailed operating instructions on the setup, operation, calibration, and maintenance of the sampler. This manual shall provide complete and detailed descriptions of the operational and calibration procedures prescribed for field use of the sampler and all instruments utilized as part of this reference method. The manual shall include adequate warning of potential safety hazards that may result from normal use or malfunction of the method and a description of necessary safety precautions. The manual shall also include a clear description of all procedures pertaining to installation, operation, periodic and corrective maintenance, and troubleshooting, and shall include parts identification diagrams.

7.4.19 *Data reporting requirements.* The various information that the sampler is required to provide and how it is to be provided is summarized in the following Table L–1.

TABLE L–1.—SUMMARY OF INFORMATION TO BE PROVIDED BY THE SAMPLER

Information to be provided	Appendix L section reference	Availability				Format	
		Anytime[1]	End of period[2]	Visual display[3]	Data output[4]	Digital reading[5]	Units
Flow rate, 30-second maximum interval.	7.4.5.1	✔	....	✔	*	XX.X	L/min
Flow rate, average for the sample period.	7.4.5.2	*	✔	*	✔	XX.X	L/min
Flow rate, CV, for sample period.	7.4.5.2	*	✔	*	✔●	XX.X	%
Flow rate, 5-min. average out of spec. (FLAG[6]).	7.4.5.2	✔	✔	✔	✔●	On/Off	
Sample volume, total	7.4.5.2	*	✔	✔	✔●	XX.X	m^3
Temperature, ambient, 30-second interval.	7.4.8	✔	....	✔	....	XX.X	°C
Temperature, ambient, min., max., average for the sample period.	7.4.8	*	✔	✔	✔●	XX.X	°C
Baro pressure, ambient, 30-second interval.	7.4.9	✔	....	✔	....	XXX	mm Hg
Baro pressure, ambient, min., max., average for the sample period.	7.4.9	*	✔	✔	✔●	XXX	mm Hg
Filter temperature, 30-second interval.	7.4.11	✔	....	✔	....	XX.X	°C
Filter temperature differential, 30-second interval, out of spec. (FLAG[6]).	7.4.11	*	✔	✔	✔●	On/Off	
Filter temperature, maximum differential from ambient, date, time of occurrence.	7.4.11	*	*	*	*	X.X, YY/MM/DD HH:mm.	°C, Yr./Mon./Day Hrs. min
Date and time	7.4.12	✔	....	✔	....	YY/MM/DD HH:mm	Yr./Mon./Day Hrs. min
Sample start and stop time settings.	7.4.12	✔	✔	✔	✔	YY/MM/DD HH:mm	Yr./Mon./Day Hrs. min
Sample period start time.	7.4.12	....	✔	✔	✔●	YYYY/MM/DD HH:mm	Yr./Mon./Day Hrs. min
Elapsed sample time	7.4.13	*	✔	✔	✔●	HH:mm	Hrs. min
Elapsed sample time, out of spec. (FLAG[6]).	7.4.13	....	✔	✔	✔●	On/Off	
Power interruptions >1 min., start time of first 10.	7.4.15.5	*	✔	*	✔	1HH:mm, 2HH:mm, etc	Hrs. min
User-entered information, such as sampler and site identification.	7.4.16	✔	✔	✔	✔●	As entered	

✔ Provision of this information is required.
Provision of this information is optional. If information related to the entire sample period is optionally provided prior to the end of the sample period, the value provided should be the value calculated for the portion of the sampler period completed up to the time the information is provided.
● Indicates that this information is also required to be provided to the AIRS data bank; see §§ 58.26 and 58.35 of this chapter.

[1] Information is required to be available to the operator at any time the sampler is operating, whether sampling or not.
[2] Information relates to the entire sampler period and must be provided following the end of the sample period until reset manually by the operator or automatically by the sampler upon the start of a new sample period.
[3] Information shall be available to the operator visually.
[4] Information is to be available as digital data at the sampler's data output port specified in section 7.4.16 of this appendix following the end of the sample period until reset manually by the operator or automatically by the sampler upon the start of a new sample period.
[5] Digital readings, both visual and data output, shall have not less than the number of significant digits and resolution specified.
[6] Flag warnings may be displayed to the operator by a single-flag indicator or each flag may be displayed individually. Only a set (on) flag warning must be indicated; an off (unset) flag may be indicated by the absence of a flag warning. Sampler users should refer to section 10.12 of this appendix regarding the validity of samples for which the sampler provided an associated flag warning.

8.0 *Filter Weighing.* See reference 2 in section 13.0 of this appendix, for additional, more detailed guidance.

8.1 *Analytical balance.* The analytical balance used to weigh filters must be suitable for weighing the type and size of filters specified, under section 6.0 of this appendix, and have a readability of ±1 μg. The balance shall be calibrated as specified by the manufacturer at installation and recalibrated immediately prior to each weighing session. See reference 2 in section 13.0 of this appendix for additional guidance.

8.2 *Filter conditioning.* All sample filters used shall be conditioned immediately before both the pre- and post-sampling weighings as specified below. See reference 2 in section 13.0 of this appendix for additional guidance.

8.2.1 *Mean temperature.* 20 - 23 °C.

8.2.2 *Temperature control.* ±2 °C over 24 hours.

8.2.3 *Mean humidity.* Generally, 30–40 percent relative humidity; however, where it can be shown that the mean ambient relative humidity during sampling is less than 30 percent, conditioning is permissible at a mean relative humidity within ±5 relative humidity percent of the mean ambient relative humidity during sampling, but not less than 20 percent.

8.2.4 *Humidity control.* ±5 relative humidity percent over 24 hours.

8.2.5 *Conditioning time.* Not less than 24 hours.

8.3 *Weighing procedure.*

8.3.1 New filters should be placed in the conditioning environment immediately upon arrival and stored there until the pre-sampling weighing. See reference 2 in section 13.0 of this appendix for additional guidance.

8.3.2 The analytical balance shall be located in the same controlled environment in which the filters are conditioned. The filters shall be weighed immediately following the conditioning period without intermediate or transient exposure to other conditions or environments.

8.3.3 Filters must be conditioned at the same conditions (humidity within ±5 relative humidity percent) before both the pre- and post-sampling weighings.

8.3.4 Both the pre- and post-sampling weighings should be carried out on the same analytical balance, using an effective technique to neutralize static charges on the filter, under reference 2 in section 13.0 of this appendix. If possible, both weighings should be carried out by the same analyst.

8.3.5 The pre-sampling (tare) weighing shall be within 30 days of the sampling period.

8.3.6 The post-sampling conditioning and weighing shall be completed within 240 hours (10 days) after the end of the sample period, unless the filter sample is maintained at 4 °C or less during the entire time between retrieval from the sampler and the start of the conditioning, in which case the period shall not exceed 30 days. Reference 2 in section 13.0 of this appendix has additional guidance on transport of cooled filters.

8.3.7 Filter blanks.

8.3.7.1 New field blank filters shall be weighed along with the pre-sampling (tare) weighing of each lot of $PM_{2.5}$ filters. These blank filters shall be transported to the sampling site, installed in the sampler, retrieved from the sampler without sampling, and reweighed as a quality control check.

8.3.7.2 New laboratory blank filters shall be weighed along with the pre-sampling (tare) weighing of each set of $PM_{2.5}$ filters. These laboratory blank filters should remain in the laboratory in protective containers during the field sampling and should be reweighed as a quality control check.

8.3.8 Additional guidance for proper filter weighing and related quality assurance activities is provided in reference 2 in section 13.0 of this appendix.

9.0 *Calibration.* Reference 2 in section 13.0 of this appendix contains additional guidance.

9.1 *General requirements.*

9.1.1 Multipoint calibration and single-point verification of the sampler's flow rate measurement device must be performed periodically to establish and maintain traceability of subsequent flow measurements to a flow rate standard.

9.1.2 An authoritative flow rate standard shall be used for calibrating or verifying the sampler's flow rate measurement device with an accuracy of ±2 percent. The flow rate standard shall be a separate, stand-alone device designed to connect to the flow rate measurement adapter, Figure L–30 of this appendix. This flow rate standard must have its own certification and be traceable to a National Institute of Standards and Technology (NIST) primary standard for volume or flow rate. If adjustments to the sampler's flow rate measurement system calibration are to be made in conjunction with an audit of the sampler's flow measurement system, such adjustments shall be made following the audit. Reference 2 in section 13.0 of this appendix contains additional guidance.

9.1.3 The sampler's flow rate measurement device shall be re-calibrated after electromechanical maintenance or transport of the sampler.

9.2 *Flow rate calibration/verification procedure.*

9.2.1 $PM_{2.5}$ samplers may employ various types of flow control and flow measurement devices. The specific procedure used for calibration or verification of the flow rate measurement device will vary depending on the type of flow rate controller and flow rate measurement employed. Calibration shall be in terms of actual ambient volumetric flow rates (Q^a), measured at the sampler's inlet downtube. The generic procedure given here serves to illustrate the general steps involved in the calibration of a $PM_{2.5}$ sampler. The sampler operation/instruction manual required under section 7.4.18 of this appendix and the Quality Assurance Handbook in reference 2 in section 13.0 of this appendix provide more specific and detailed guidance for calibration.

9.2.2 The flow rate standard used for flow rate calibration shall have its own certification and be traceable to a NIST primary standard for volume or flow rate. A calibration relationship for the flow rate standard, e.g., an equation, curve, or family of curves relating actual flow rate (Q_a) to the flow rate indicator reading, shall be established that is accurate to within 2 percent over the expected range of ambient temperatures and pressures at which the flow rate standard may be used. The flow rate standard must be re-calibrated or re-verified at least annually.

9.2.3 The sampler flow rate measurement device shall be calibrated or verified by removing the sampler inlet and connecting the flow rate standard to the sampler's downtube in accordance with the operation/instruction manual, such that the flow rate standard accurately measures the sampler's flow rate. The sampler operator shall first carry out a sampler leak check and confirm that the sampler passes the leak test and then verify that no leaks exist between the flow rate standard and the sampler.

9.2.4 The calibration relationship between the flow rate (in actual L/min) indicated by the flow rate standard and by the sampler's flow rate measurement device shall be established or verified in accordance with the sampler operation/ instruction manual. Temperature and pressure corrections to the flow rate indicated by the flow rate standard may be required for certain types of flow rate standards. Calibration of the sampler's flow rate measurement device shall consist of at least three separate flow rate measurements (multipoint calibration) evenly spaced within the range of -10 percent to +10 percent of the sampler's operational flow rate, section 7.4.1 of this appendix. Verification of the sampler's flow rate shall consist of one flow rate measurement at the sampler's operational flow rate. The sampler operation/instruction manual and reference 2 in section 13.0 of this appendix provide additional guidance.

9.2.5 If during a flow rate verification the reading of the sampler's flow rate indicator or measurement device differs by ±2 percent or more from the flow rate measured by the flow rate standard, a new multipoint calibration shall be performed and the flow rate verification must then be repeated.

9.2.6 Following the calibration or verification, the flow rate standard shall be removed from the sampler and the sampler inlet shall be reinstalled. Then the sampler's normal operating flow rate (in L/min) shall be determined with a clean filter in place. If the flow rate indicated by the sampler differs by ±2 percent or more from the required sampler flow rate, the sampler flow rate must be adjusted to the required flow rate, under section 7.4.1 of this appendix.

9.3 Periodic calibration or verification of the calibration of the sampler's ambient temperature, filter temperature, and barometric pressure measurement systems is also required. Reference 3 of section 13.0 of this appendix contains additional guidance.

10.0 *$PM_{2.5}$ Measurement Procedure* The detailed procedure for obtaining valid $PM_{2.5}$ measurements with each specific sampler designated as part of a reference method for $PM_{2.5}$ under part 53 of this chapter shall be provided in the sampler-specific operation or instruction manual required by section 7.4.18 of this appendix. Supplemental guidance is provided in section 2.12 of the Quality Assurance Handbook listed in reference 2 in section 13.0 of this appendix. The generic procedure given here serves to illustrate the general steps involved in the $PM_{2.5}$ sample collection and measurement, using a $PM_{2.5}$ reference method sampler.

10.1 The sampler shall be set up, calibrated, and operated in accordance with the specific, detailed guidance provided in the specific sampler's operation or instruction manual and in accordance with a specific quality assurance program developed and established by the user, based on applicable supplementary guidance provided in reference 2 in section 13.0 of this appendix.

10.2 Each new sample filter shall be inspected for correct type and size and for pinholes, particles, and other imperfections. Unacceptable filters should be discarded. A unique identification number shall be assigned to each filter, and an information record shall be established for each filter. If the filter identification number is not or cannot be marked directly on the filter, alternative means, such as a number-identified storage container, must be established to maintain positive filter identification.

10.3 Each filter shall be conditioned in the conditioning environment in accordance with the requirements specified in section 8.2 of this appendix.

10.4 Following conditioning, each filter shall be weighed in accordance with the requirements specified in section 8.0 of this appendix and the presampling weight recorded with the filter identification number.

10.5 A numbered and preweighed filter shall be installed in the sampler following the instructions provided in the sampler operation or instruction manual.

10.6 The sampler shall be checked and prepared for sample collection in accordance with instructions provided in the sampler operation or instruction manual and with the specific quality assurance program established for the sampler by the user.

10.7 The sampler's timer shall be set to start the sample collection at the beginning of the desired sample period and stop the sample collection 24 hours later.

10.8 Information related to the sample collection (site location or identification number, sample date, filter identification number, and sampler model and serial number) shall be recorded and, if appropriate, entered into the sampler.

10.9 The sampler shall be allowed to collect the $PM_{2.5}$ sample during the set 24-hour time period.

10.10 Within 96 hours of the end of the sample collection period, the filter, while still contained in the filter cassette, shall be carefully removed from the sampler, following the procedure provided in the sampler operation or instruction manual and the quality assurance program, and placed in a protective container. This protective container shall be made of metal and contain no loose material that could be transferred to the filter. The protective container shall hold the filter cassette securely such that the cover shall not come in contact with the filter's surfaces. Reference 2 in section 13.0 of this appendix contains additional information.

10.11 The total sample volume in actual m^3 for the sampling period and the elapsed sample time shall be obtained from the sampler and recorded in accordance with the instructions provided in the sampler operation or instruction manual. All sampler warning flag indications and other information required by the local quality assurance program shall also be recorded.

10.12 All factors related to the validity or representativeness of the sample, such as sampler tampering or malfunctions, unusual meteorological conditions, construction activity, fires or dust storms, etc. shall be recorded as required by the local quality assurance program. The occurrence of a flag warning during a sample period shall not necessarily indicate an invalid sample but rather shall indicate the need for specific review of the QC data by a quality assurance officer to determine sample validity.

10.13 After retrieval from the sampler, the exposed filter containing the $PM_{2.5}$ sample should be transported to the filter conditioning environment as soon as possible ideally to arrive at the conditioning environment within 24 hours for conditioning and subsequent weighing. During the period between filter retrieval from the sampler and the start of the conditioning, the filter shall be maintained as cool as practical and continuously protected from exposure to temperatures over 25 °C. See section 8.3.6 of this appendix regarding time limits for completing the post-sampling weighing. See reference 2 in section 13.0 of this appendix for additional guidance on transporting filter samplers to the conditioning and weighing laboratory.

10.14. The exposed filter containing the $PM_{2.5}$ sample shall be re-conditioned in the conditioning environment in accordance with the requirements specified in section 8.2 of this appendix.

10.15. The filter shall be reweighed immediately after conditioning in accordance with the requirements specified in section 8.0 of this appendix, and the postsampling weight shall be recorded with the filter identification number.

10.16 The $PM_{2.5}$ concentration shall be calculated as specified in section 12.0 of this appendix.

11.0 *Sampler Maintenance*

The sampler shall be maintained as described by the sampler's manufacturer in the sampler-specific operation or instruction manual required under section 7.4.18 of this appendix and in accordance with the specific quality assurance program developed and established by the user based on applicable supplementary guidance provided in reference 2 in section 13.0 of this appendix.

12.0 *Calculations*

12.1 (a) The $PM_{2.5}$ concentration is calculated as:

$$PM_{2.5} = (W_f - W_i)/V_a$$

where:

$PM_{2.5}$ = mass concentration of $PM_{2.5}$, μg/m³;

W_f, W_i = final and initial weights, respectively, of the filter used to collect the $PM_{2.5}$ particle sample, μg;

V_a = total air volume sampled in actual volume units, as provided by the sampler, m³.

(b) Note: Total sample time must be between 1,380 and 1,500 minutes (23 and 25 hrs) for a fully valid $PM_{2.5}$ sample; however, see also section 3.3 of this appendix.

13.0 *References.*

1. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I, Principles. EPA/600/R–94/038a, April 1994. Available from CERI, ORD Publications, U.S. Environmental Protection Agency, 26 West Martin Luther King Drive, Cincinnati, Ohio 45268.

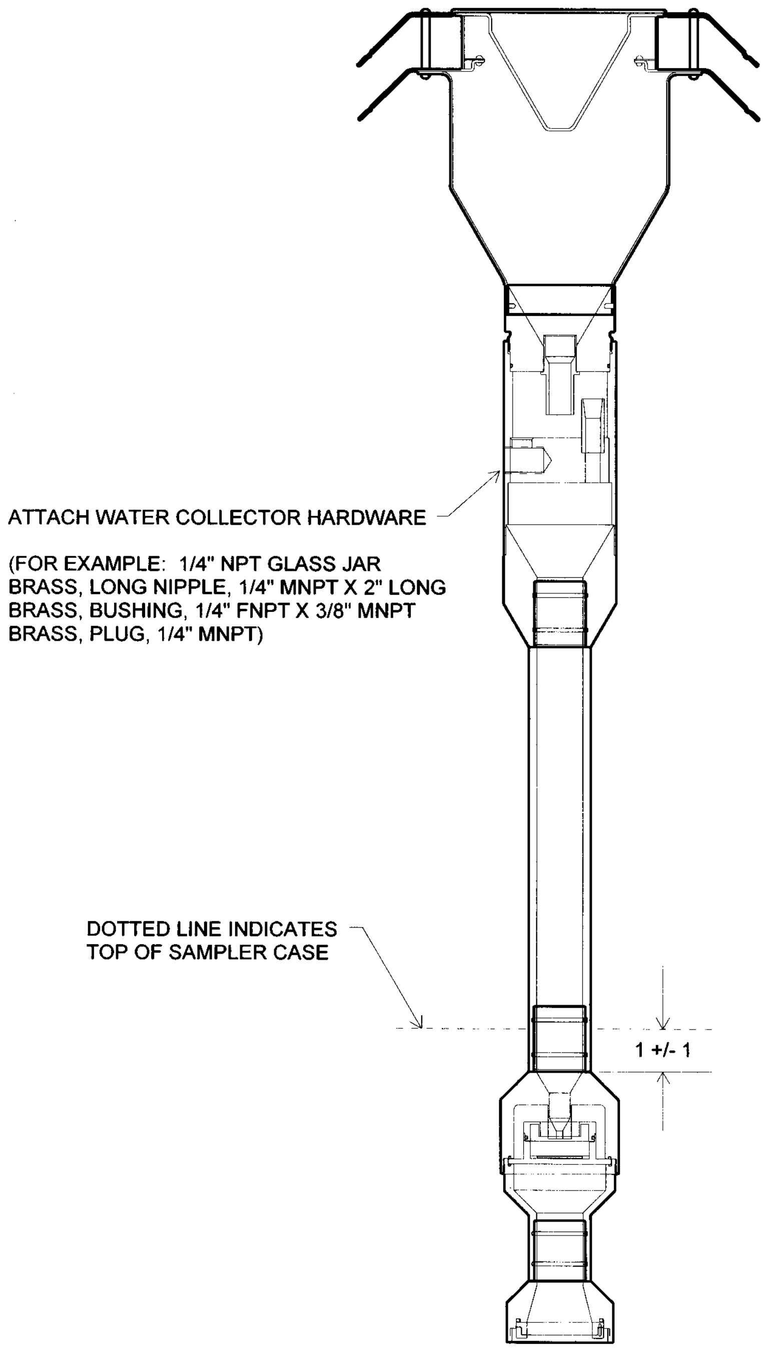
2. Copies of secton 2.12 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods, EPA/600/R–94/038b, are available from Department E (MD-77B), U.S. EPA, Research Triangle Park, NC 27711.

3. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, (Revised Edition) EPA/600/R–94/038d, March, 1995. Available from CERI, ORD Publications, U.S. Environmental Protection Agency, 26 West Martin Luther King Drive, Cincinnati, Ohio 45268.

4. Military standard specification (mil. spec.) 8625F, Type II, Class 1 as listed in Department of Defense Index of Specifications and Standards (DODISS), available from DODSSP–Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 1911–5094.

14.0 *Figures L–1 through L–30 to Appendix L.*

FIGURE L-1. PM2.5 SAMPLER, ASSEMBLY



TOLERANCES				
2 PLCS +/- 0.010	3 PLCS +/- 0.005	FRAC. +/- 1/64	ANGLE +/- 15'	ALL DIMENSIONS ARE INCHES

FIGURE L-2. 10-MICRON INLET, ASSEMBLY

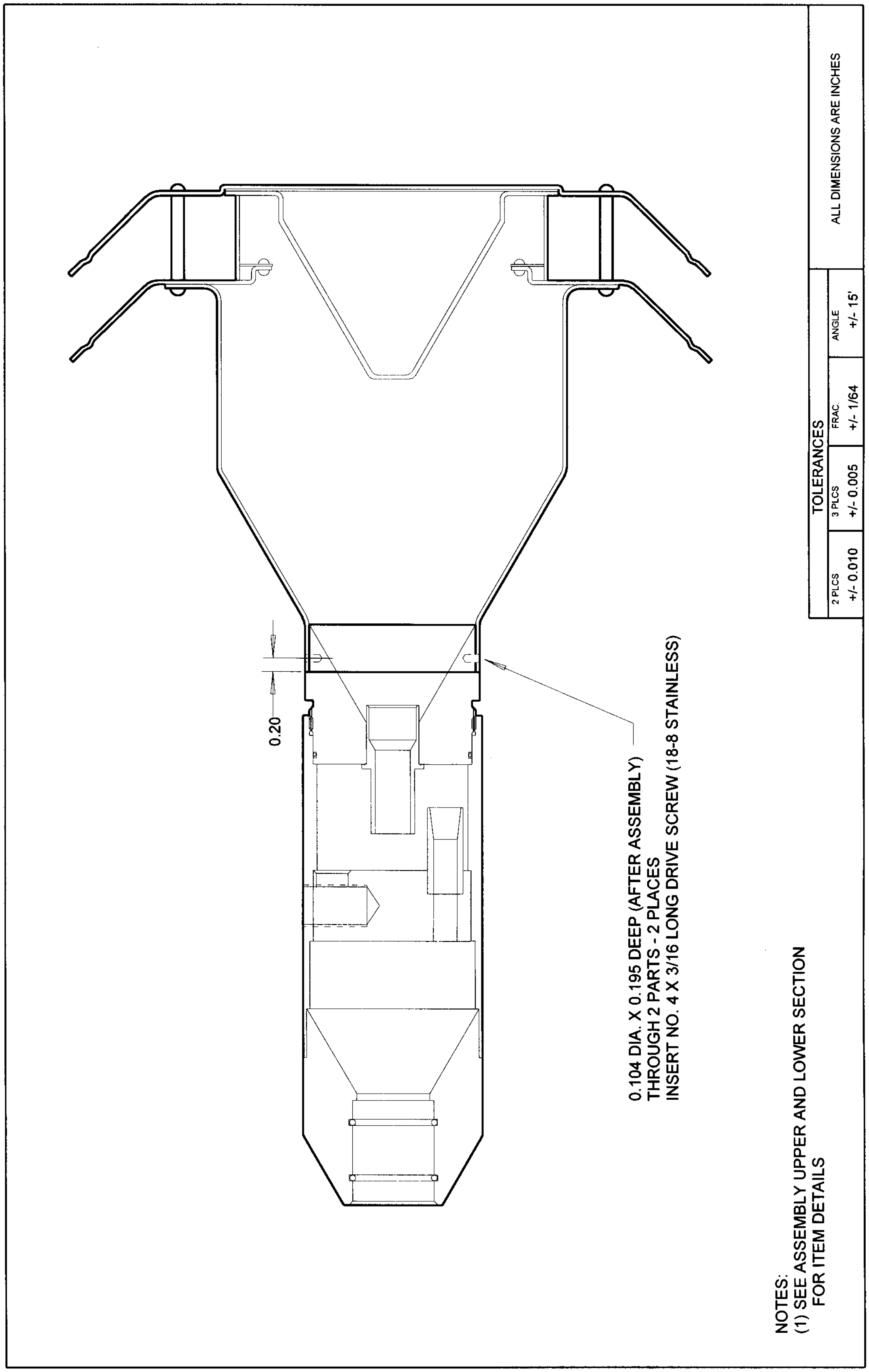
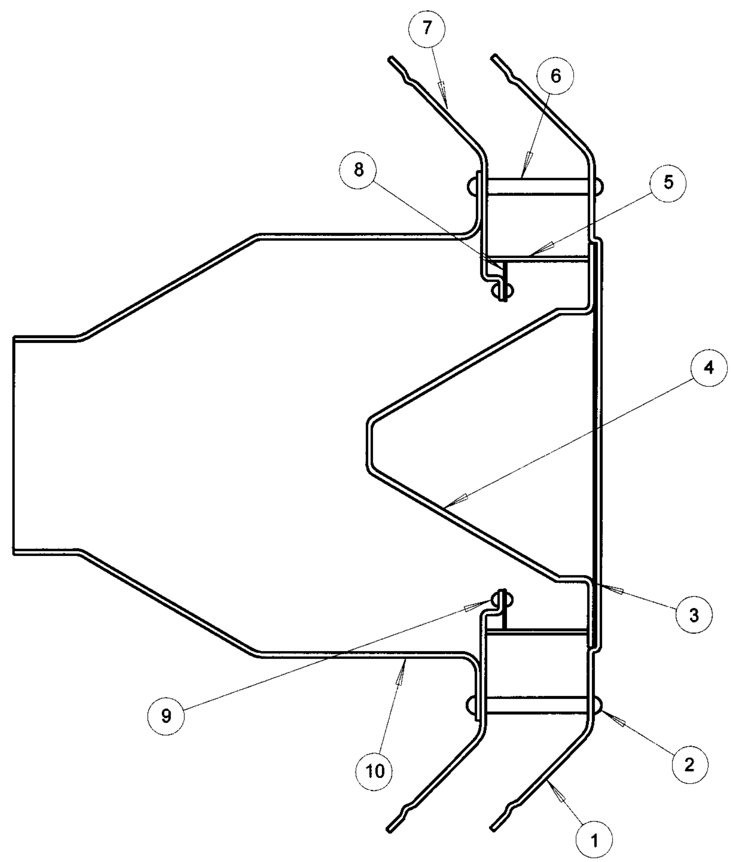


FIGURE L-3. 10-MICRON ASSEMBLY, UPPER SECTION

ITEM	DESCRIPTION	QTY.
1	10-MICRON INLET, TOP (FIGURE L-5)	1
2	6-32 X 3/8 RD. HEAD SCREW	8
3	10-MICRON GASKET (FIGURE L-6)	1
4	10-MICRON WIND DEFLECTOR (FIGURE L-7)	1
5	10-MICRON SCREEN (FIGURE L-8)	1
6	10-MICRON SPACER (FIGURE L-9)	4
7	10-MICRON INLET, LOWER (FIGURE L-11)	1
8	10-MICRON RAIN DEFLECTOR (FIGURE L-10)	1
9	1/8 DIA. RIVET	6
10	10-MICRON NOZZLE ENTRY SECT. (FIGURE L-12)	1



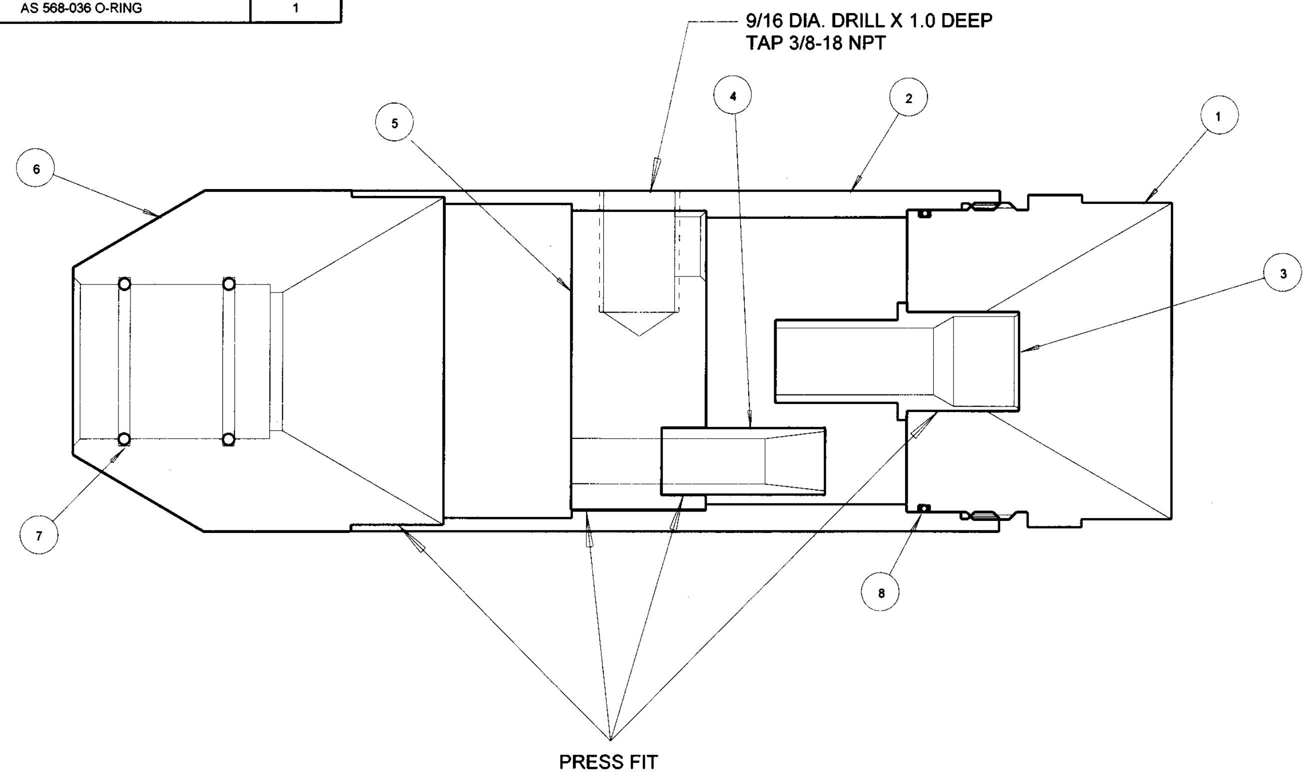
NOTES:

(1) AFFIX ITEM 3 (10-MICRON GASKET) TO ITEMS 1 (10-MICRON INLET, TOP) AND 4 (10-MICRON WIND DEFLECTOR) USING APPROPRIATE ADHESIVE

TOLERANCES				
2 PLCS	3 PLCS	FRAC	ANGLE	ALL DIMENSIONS ARE INCHES
+/- 0.010	+/- 0.005	+/- 1/64	+/- 15'	

FIGURE L-4. 10-MICRON ASSEMBLY, LOWER SECTION

ITEM	DESCRIPTION	QTY.
1	10-MICRON IMPACTOR NOZZLE (FIGURE L-13)	1
2	10-MICRON OUTER TUBE (FIGURE L-15)	1
3	10-MICRON NOZZLE INSERT (FIGURE L-14)	1
4	10-MICRON RECEIVER TUBE (FIGURE L-16)	3
5	10-MICRON TARGET PLATE (FIGURE L-17)	1
6	10-MICRON EXIT ADAPTOR (FIGURE L-18)	1
7	AS 568-026 O-RING	2
8	AS 568-036 O-RING	1



TOLERANCES				
2 PLCS	3 PLCS	FRAC.	ANGLE	ALL DIMENSIONS ARE INCHES
+/- 0.010	+/- 0.005	+/- 1/64	+/- 15'	

FIGURE L-5. 10-MICRON INLET, TOP

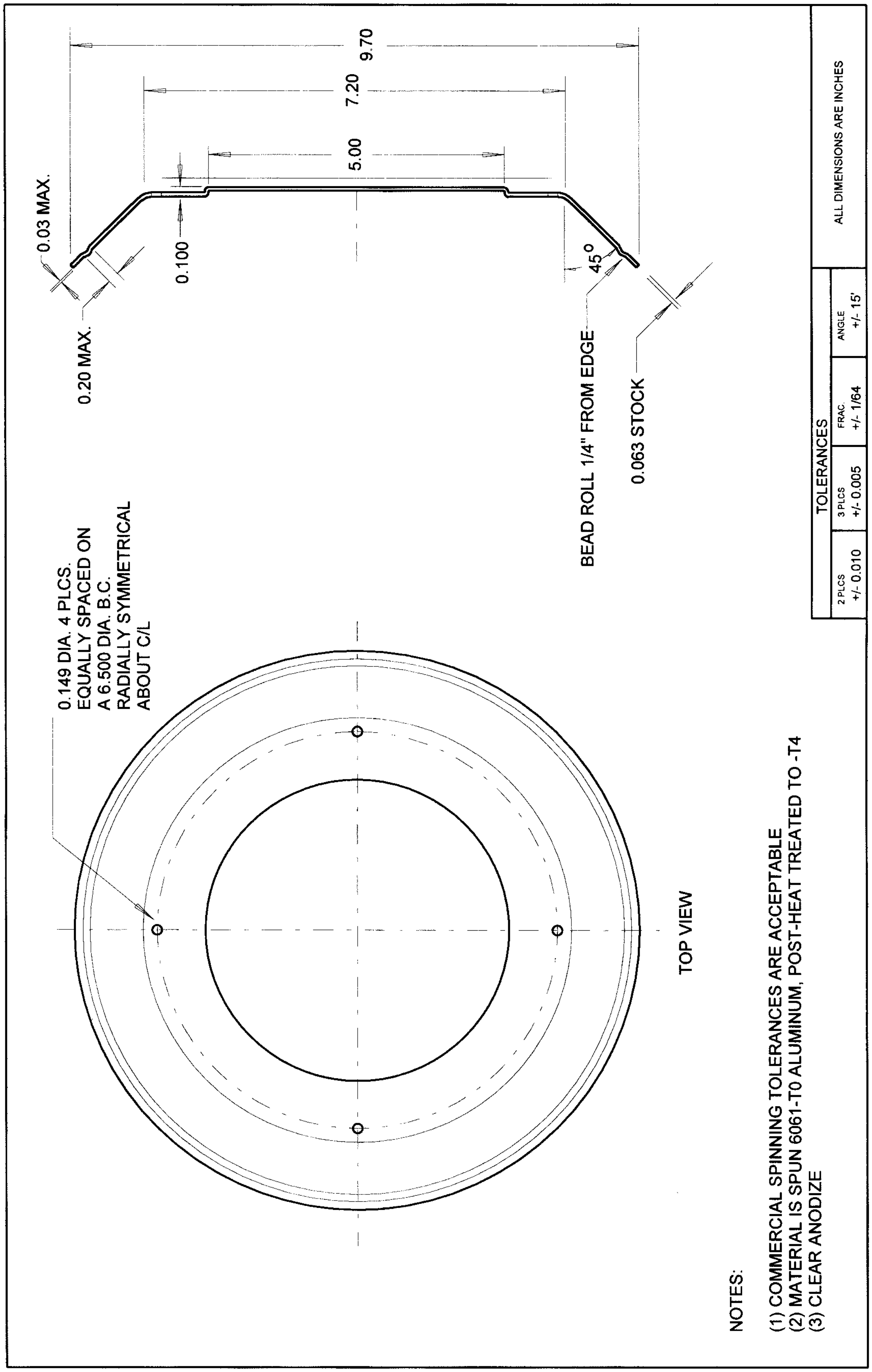


FIGURE L-6. 10-MICRON GASKET

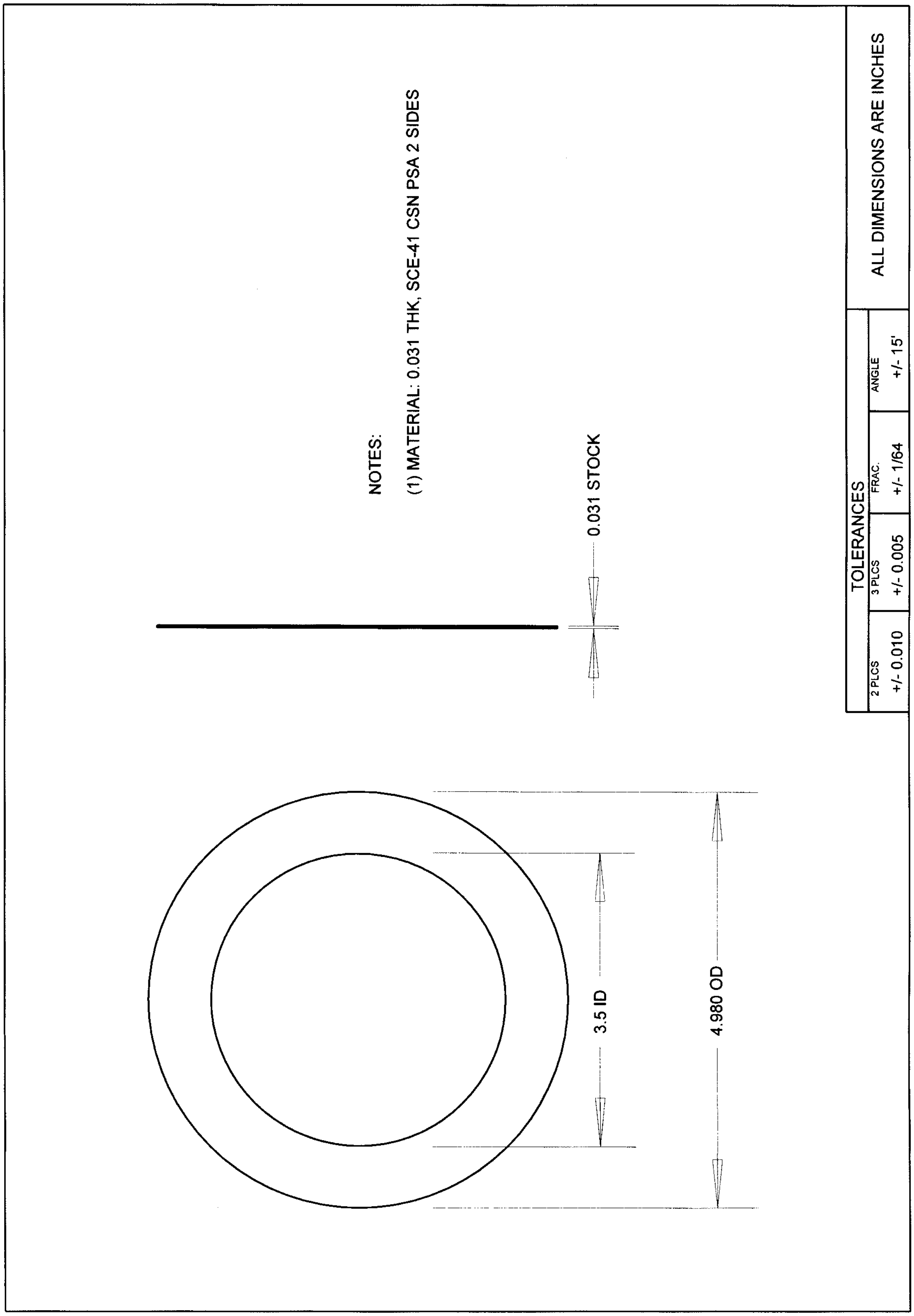


FIGURE L-7. 10-MICRON WIND DEFLECTOR

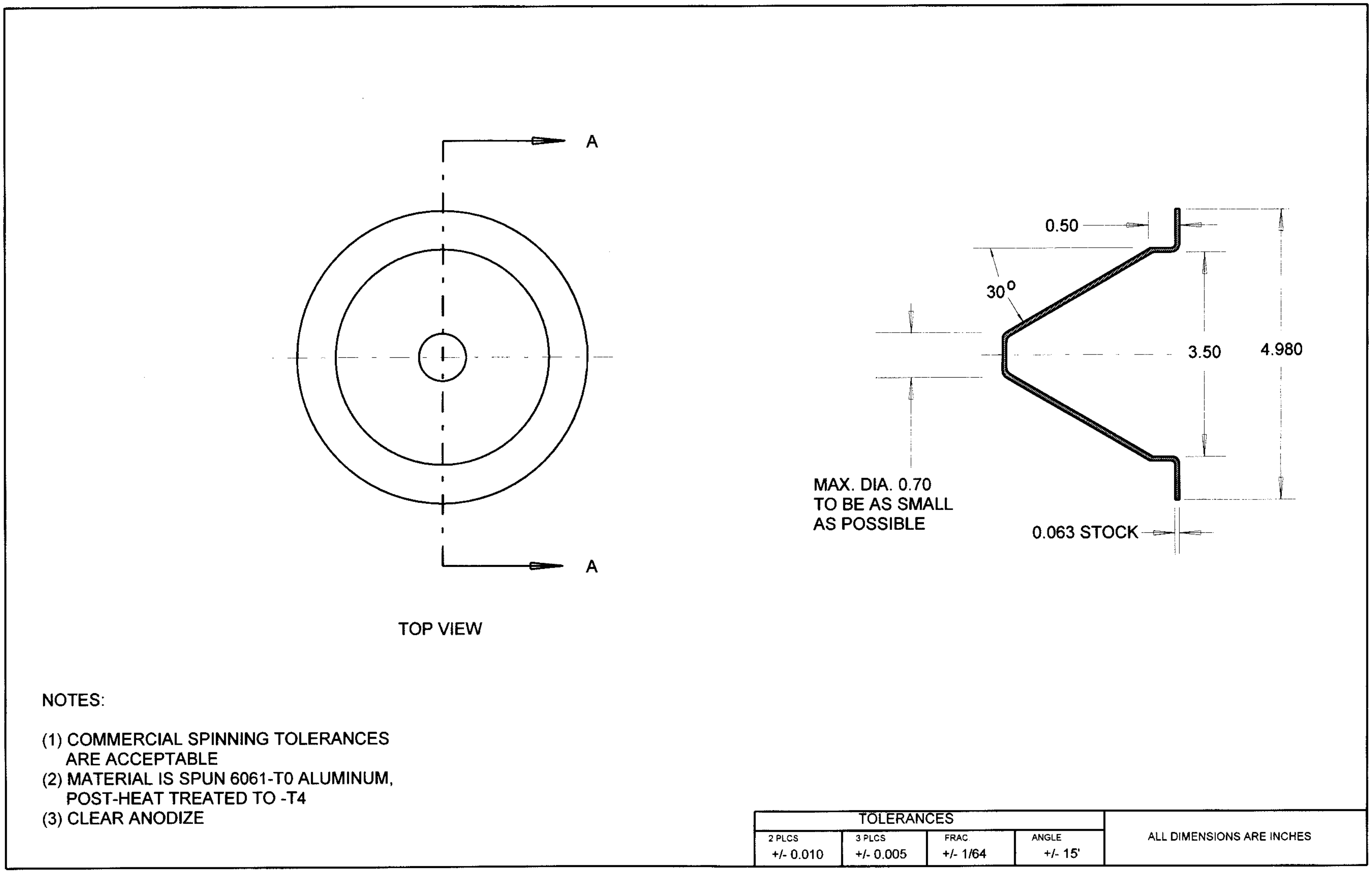


FIGURE L-8. 10-MICRON SCREEN

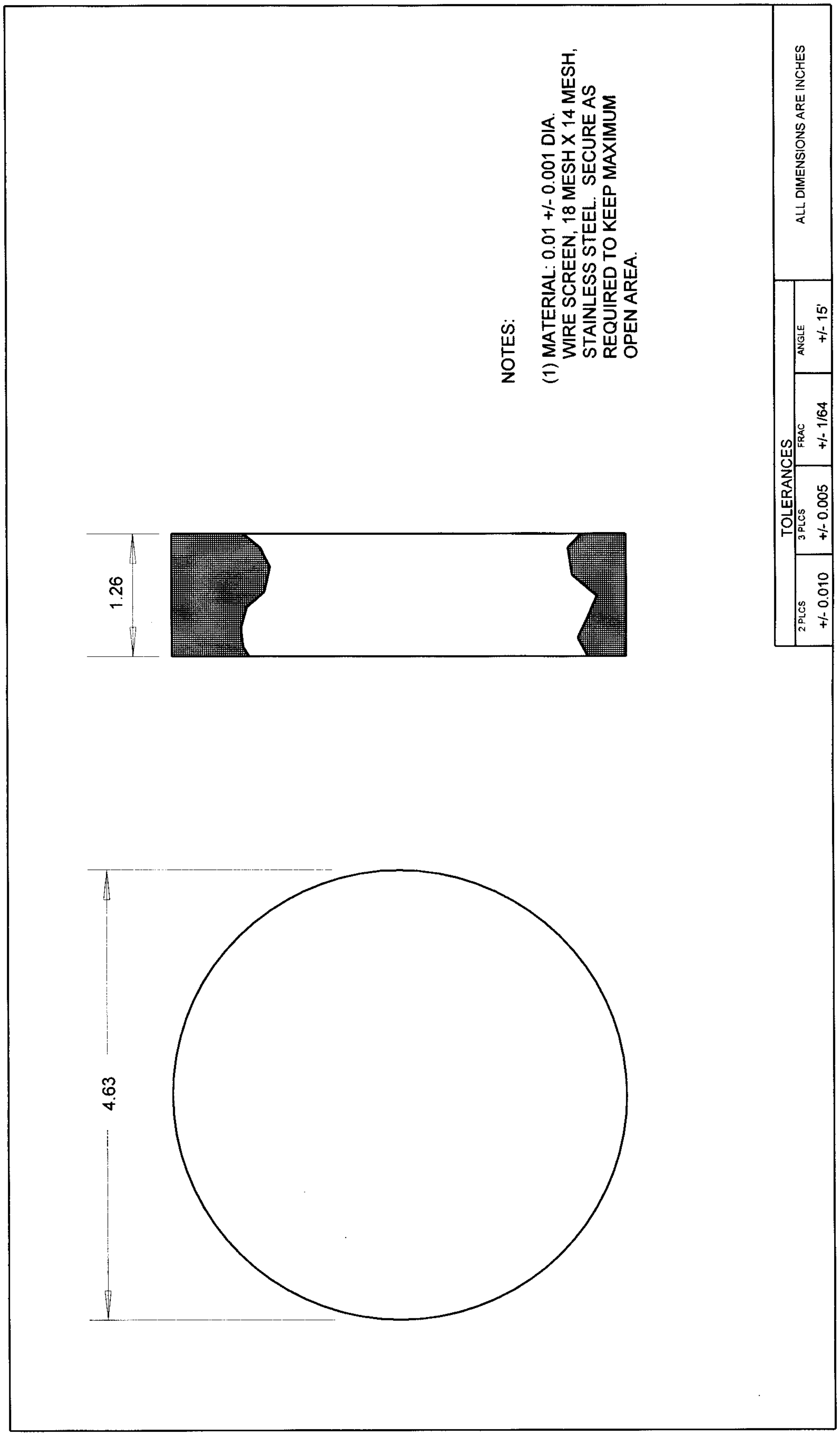


FIGURE L-9. 10-MICRON SPACER

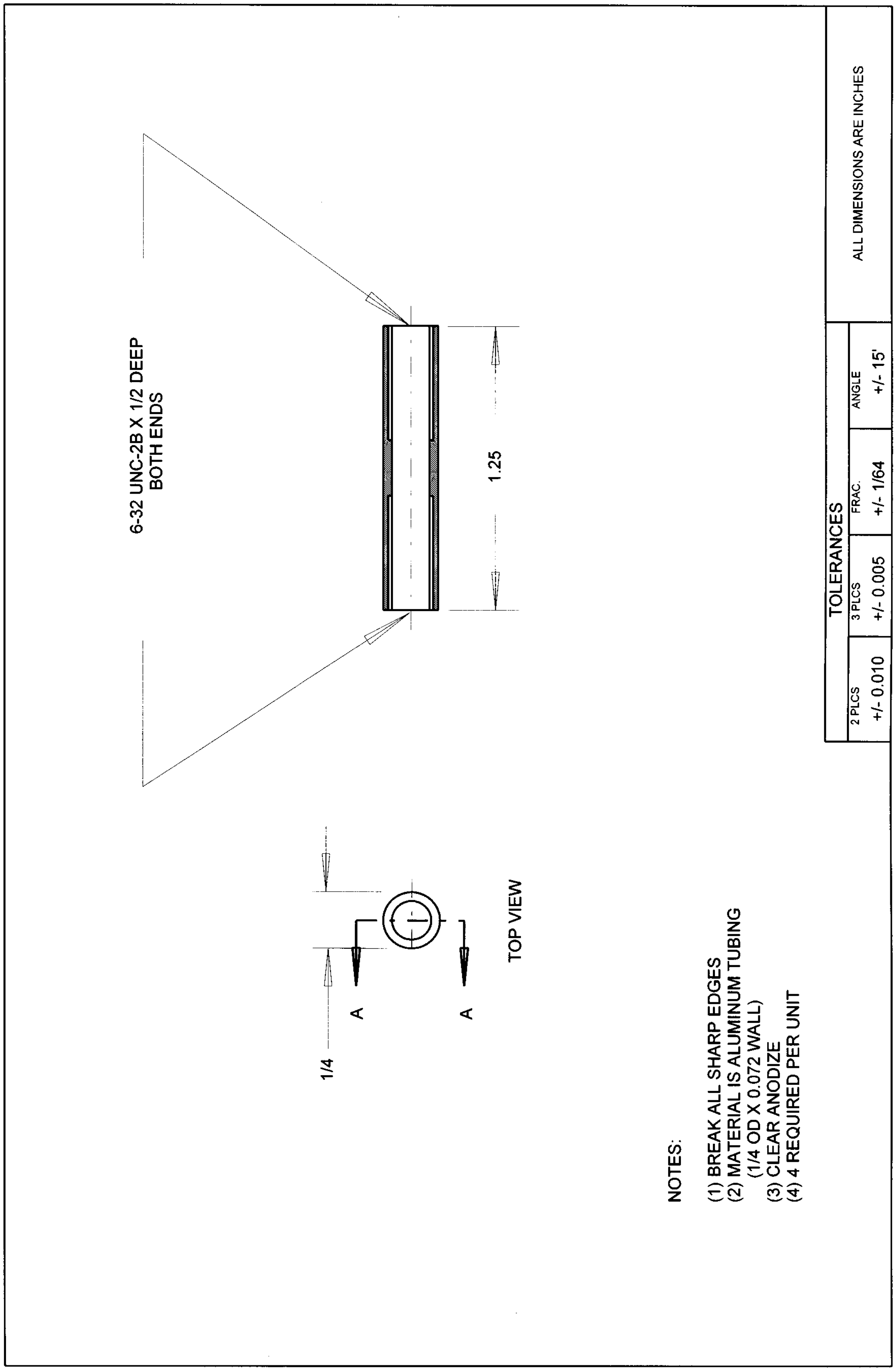


FIGURE L-10. 10-MICRON RAIN DEFLECTOR

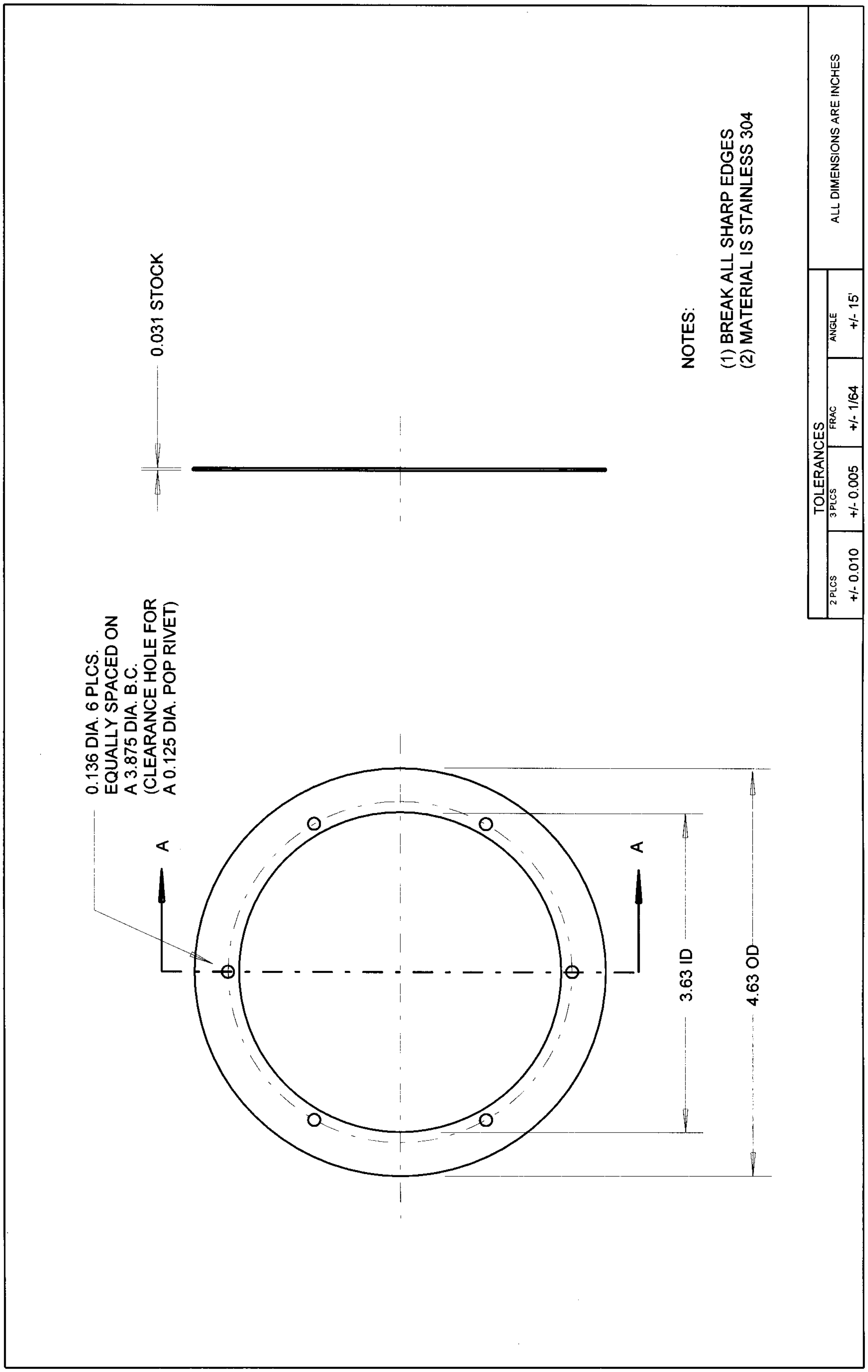


FIGURE L-11. 10-MICRON INLET, LOWER

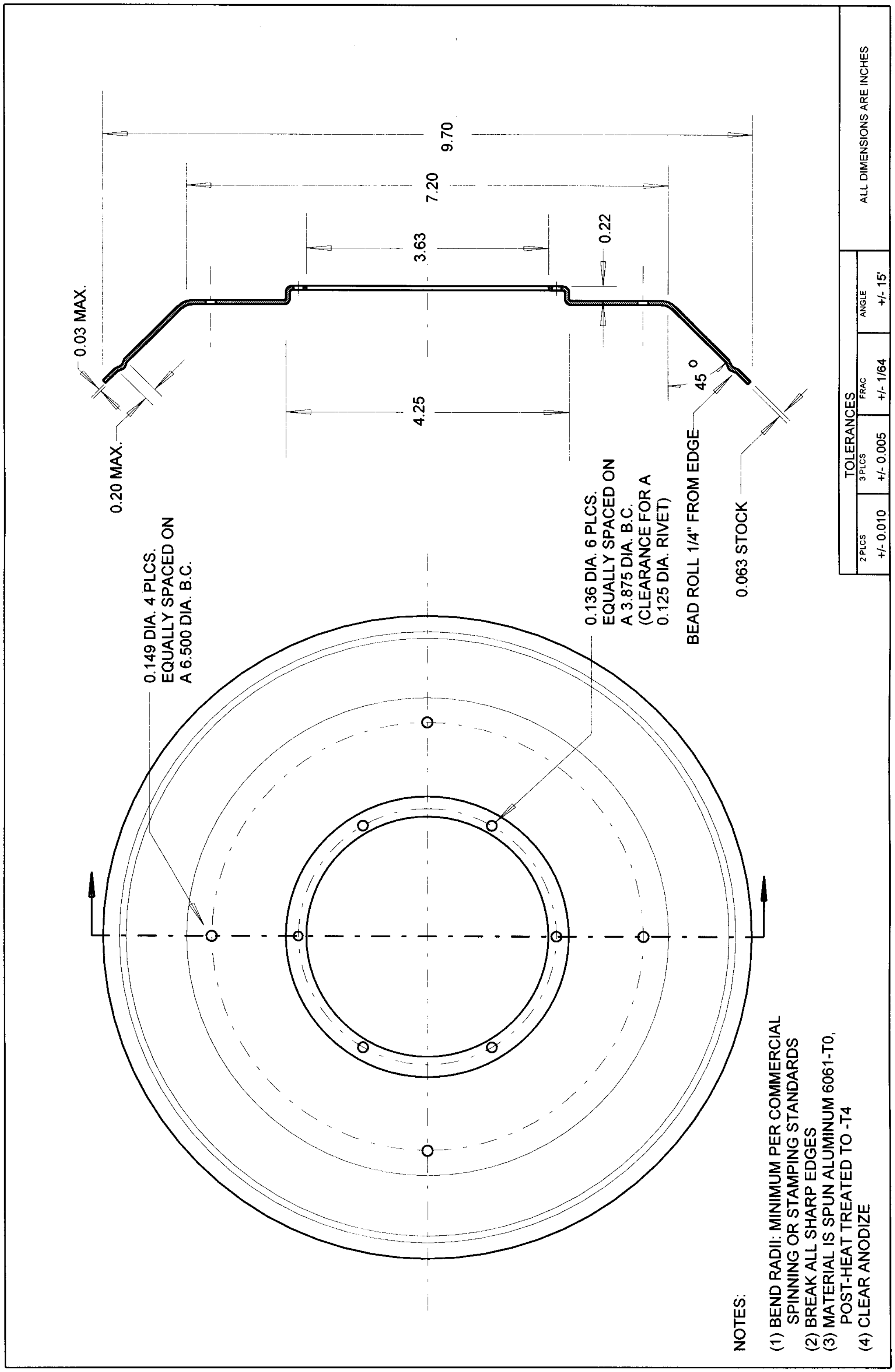


FIGURE L-12. 10-MICRON NOZZLE ENTRY SECTION

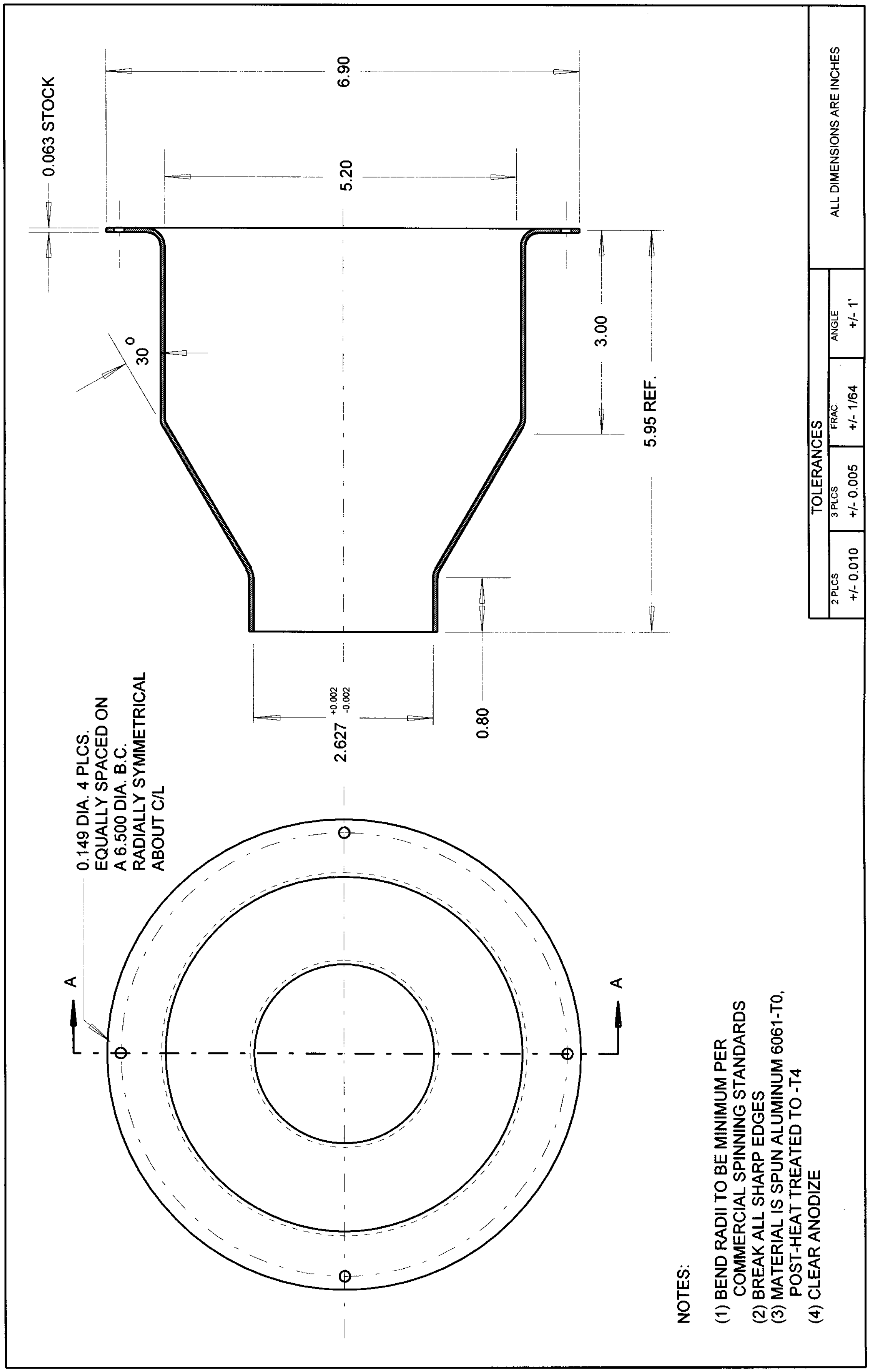


FIGURE L-13. 10-MICRON IMPACTOR NOZZLE

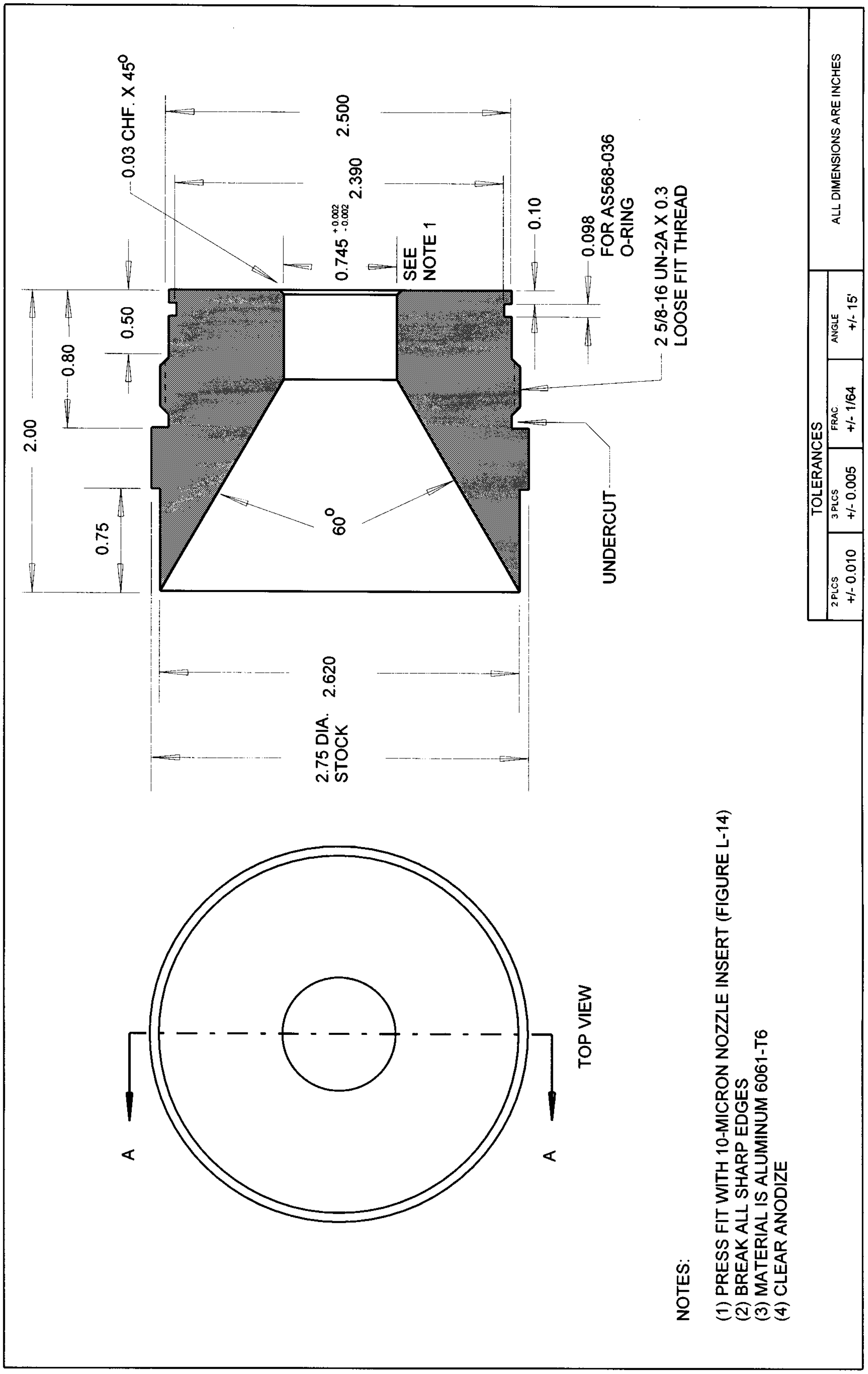
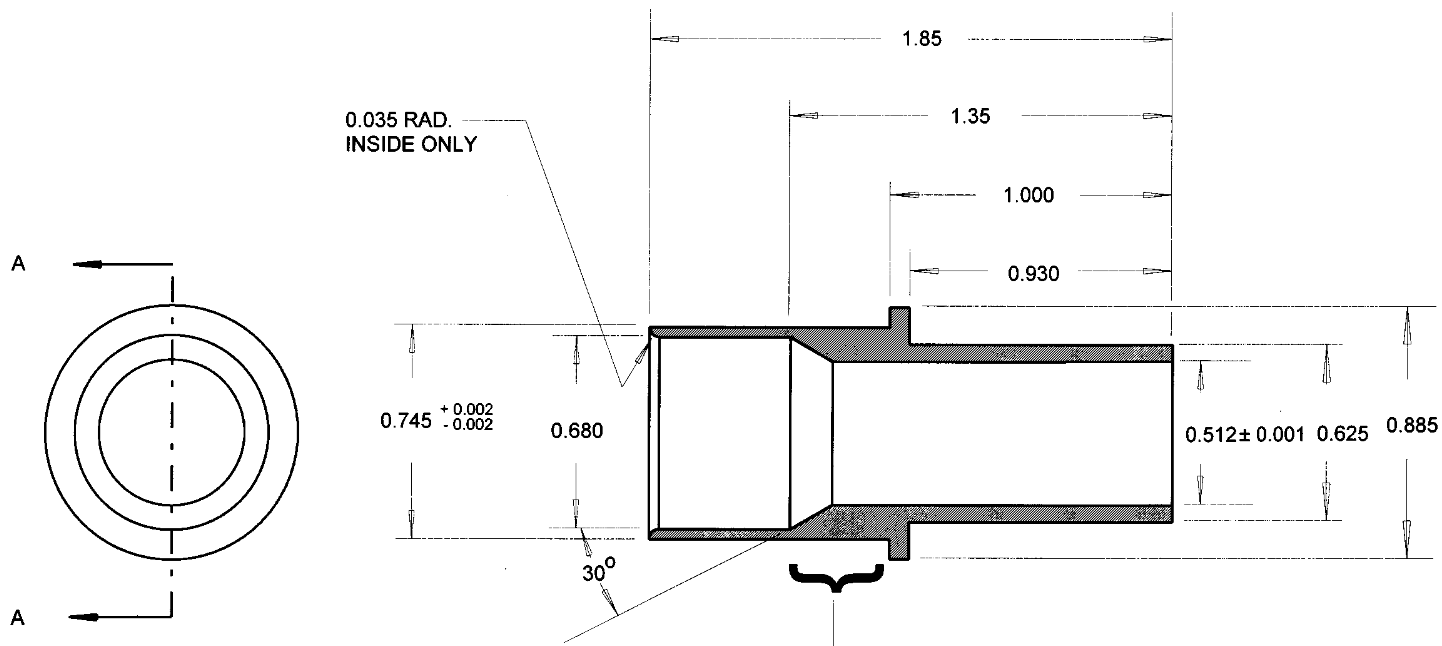


FIGURE L-14. 10-MICRON NOZZLE INSERT



NOTES:

(1) PRESS FIT INTO 10-MICRON IMPACTOR NOZZLE (FIGURE L-13)
(2) BREAK ALL SHARP EDGES
(3) MATERIAL IS ALUMINUM 6061-T6
(4) CLEAR ANODIZE
(5) FINISH #63

TOLERANCES				
2 PLCS	3 PLCS	FRAC.	ANGLE	ALL DIMENSIONS ARE INCHES
+/- 0.010	+/- 0.005	+/- 1/64	+/- 15'	

FIGURE L-15. 10-MICRON OUTER TUBE

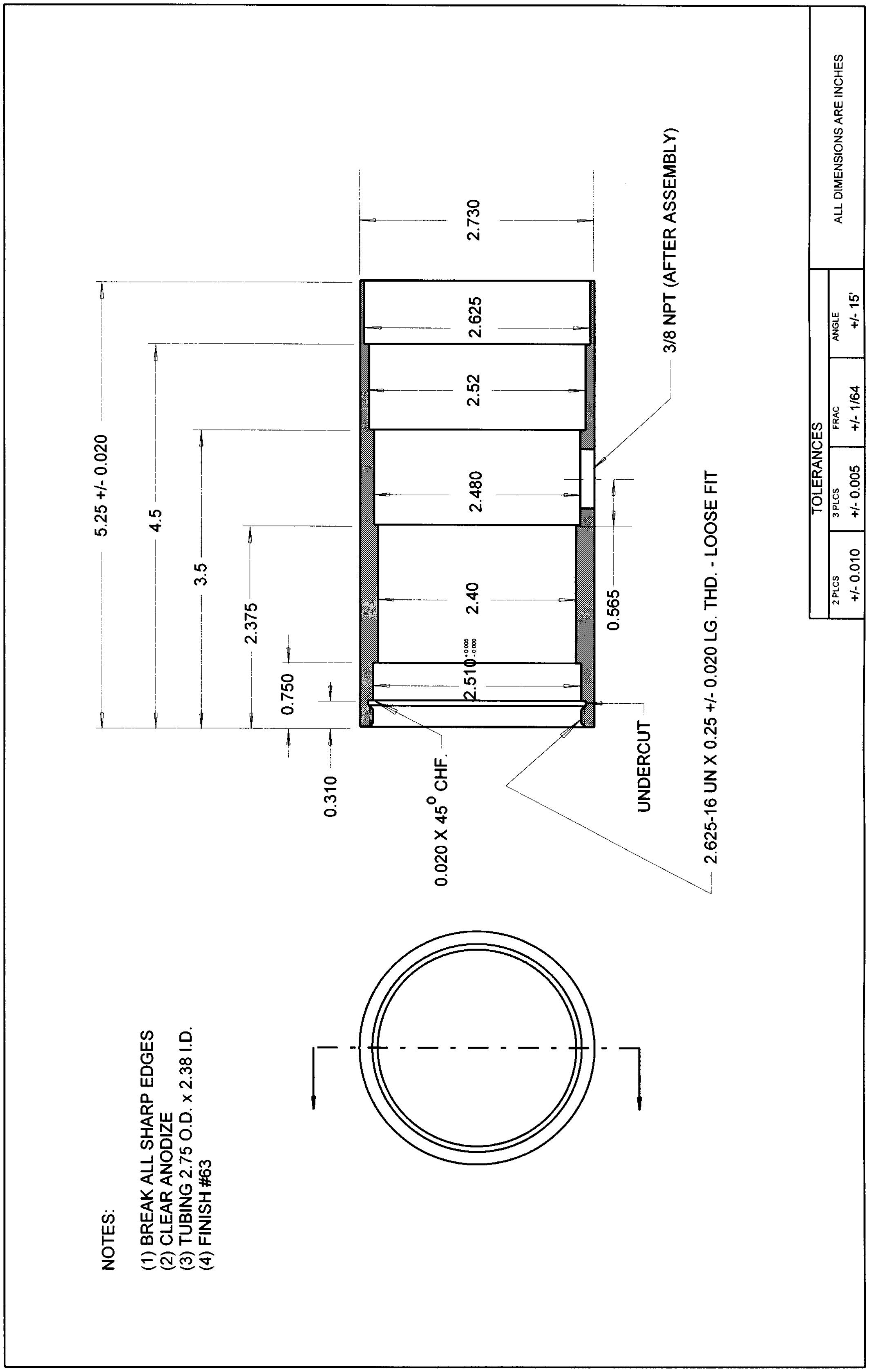
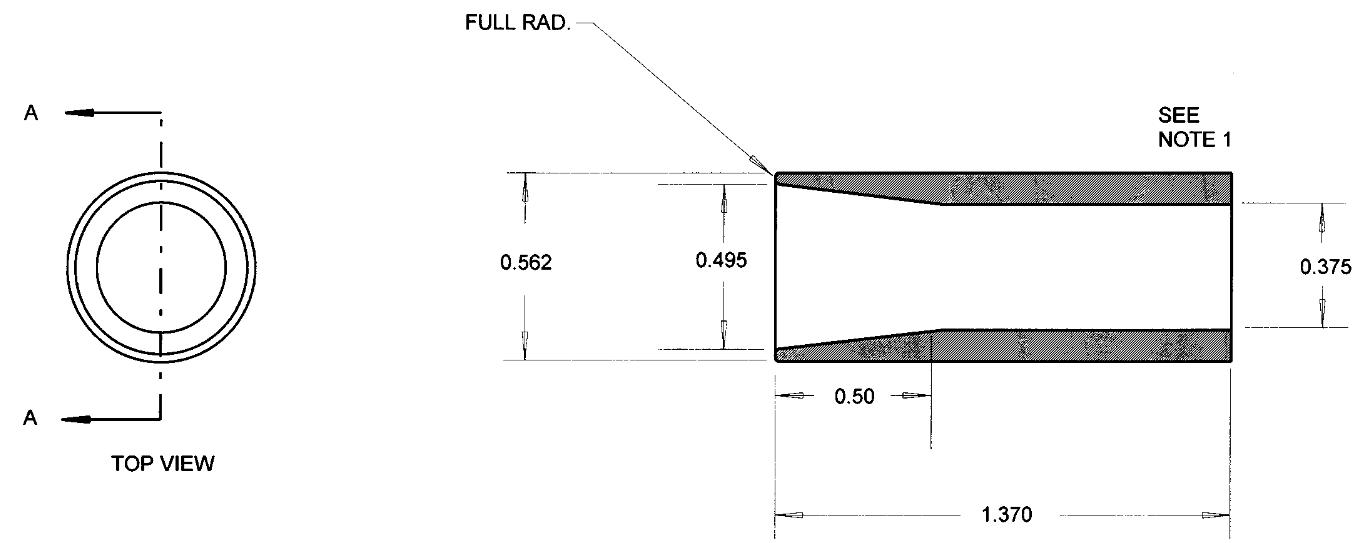


FIGURE L-16. 10-MICRON RECEIVER TUBE



NOTES:

(1) 0.562 DIA. O.D. TO PRESS INTO 10-MICRON TARGET PLATE (FIGURE L-17)
(2) BREAK ALL SHARP EDGES
(3) MATERIAL IS ALUMINUM 6061-T6
(4) CLEAR ANODIZE
(5) FINISH #63
(6) 3 REQ'D PER UNIT

TOLERANCES				
2 PLCS	3 PLCS	FRAC.	ANGLE	ALL DIMENSIONS ARE INCHES
+/- 0.010	+/- 0.005	+/- 1/64	+/- 15'	

FIGURE L-17. 10-MICRON TARGET PLATE

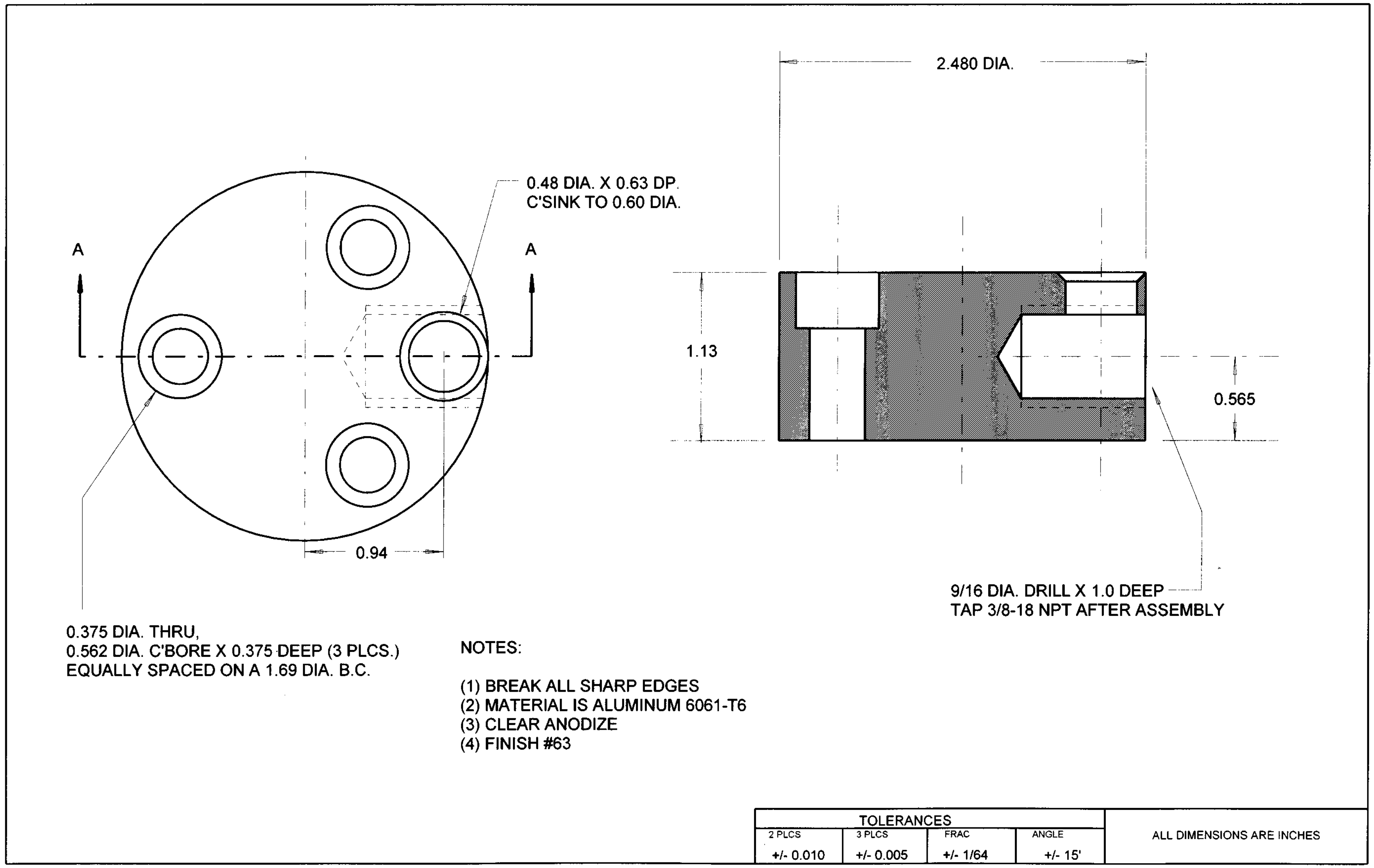


FIGURE L-18. 10-MICRON EXIT ADAPTOR

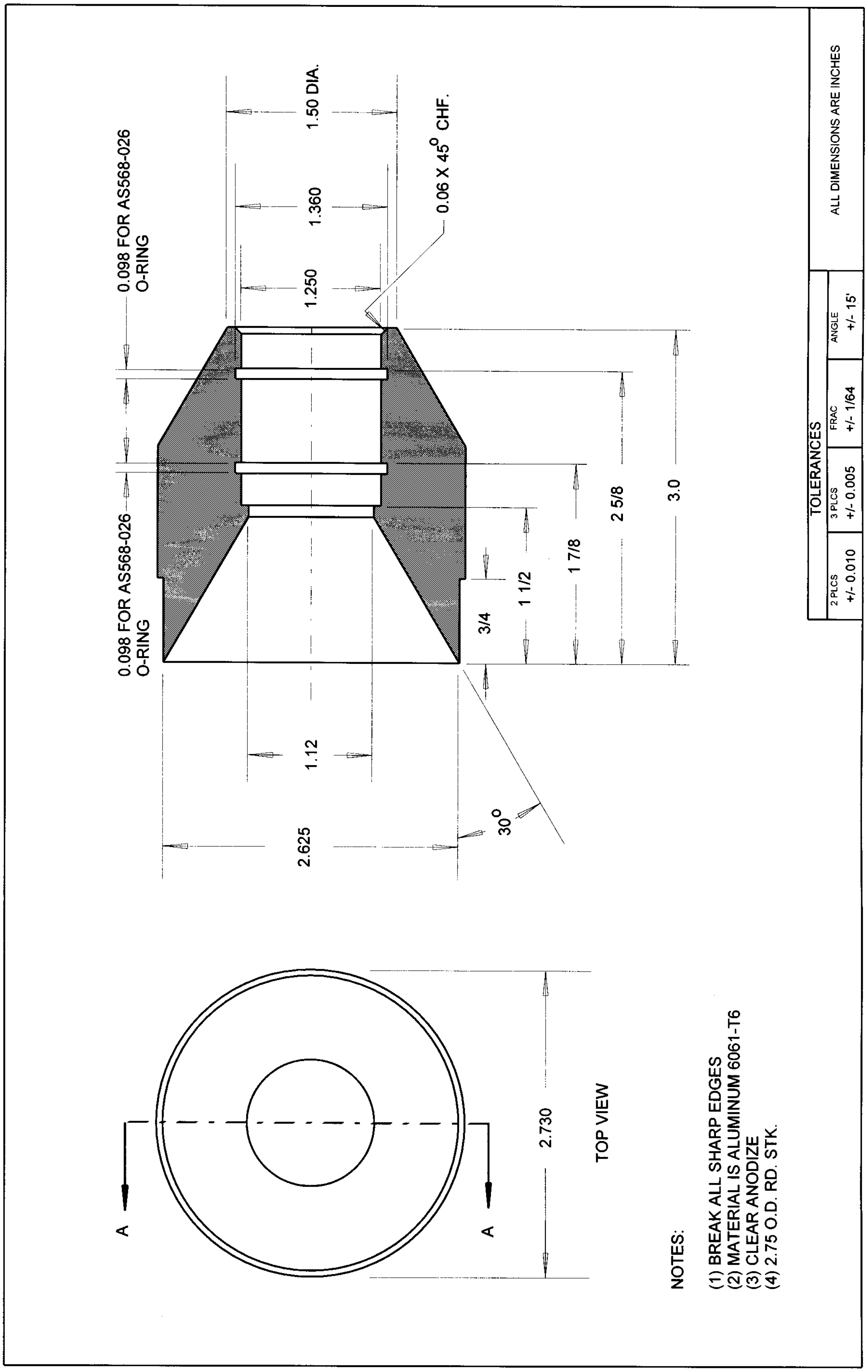


FIGURE L-19. 10-MICRON DOWN TUBE

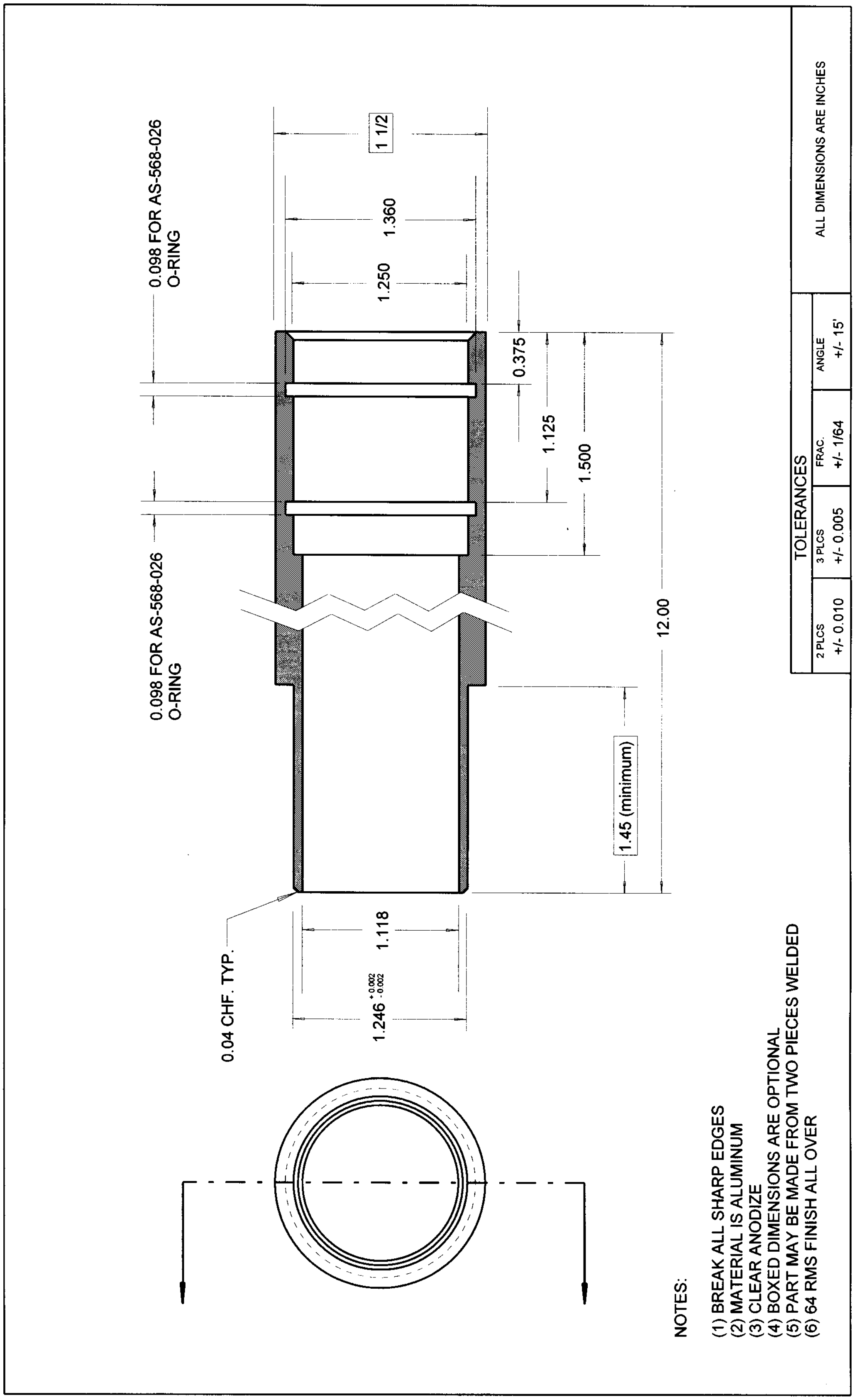
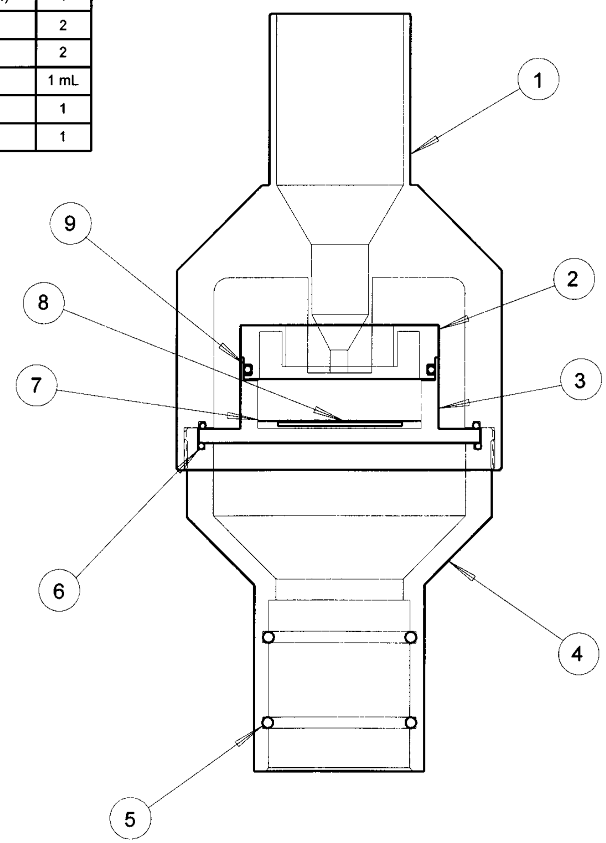


FIGURE L-20. 2.5-MICRON IMPACTOR ASSEMBLY

ITEM	DESCRIPTION	QTY.
1	2.5-MICRON IMPACTOR HOUSING, UPPER (FIGURE L-21)	1
2	2.5-MICRON IMPACTOR WELL, UPPER (FIGURE L-22)	1
3	2.5-MICRON IMPACTOR WELL, LOWER (FIGURE L-23)	1
4	2.5-MICRON IMPACTOR HOUSING, LOWER (FIGURE L-24)	1
5	O-RING: AS568-026	2
6	O-RING: AS568-036 (VITON®)	2
7	IMPACTION OIL	1 mL
8	FILTER	1
9	O-RING: AS568-030 (VITON®)	1



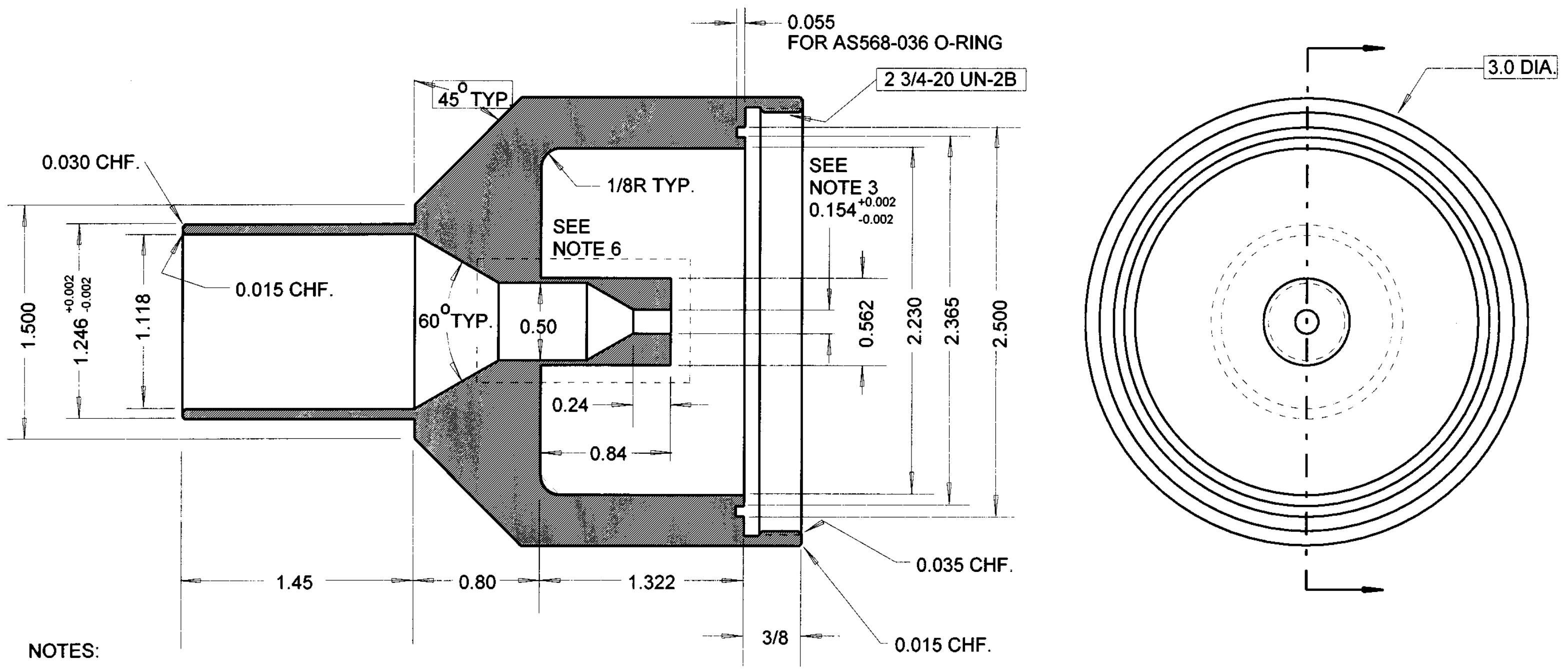
VITON® IS A TRADEMARK OF DUPONT DOW ELASTOMERS L.L.C.

USE OF THIS NAME DOES NOT CONSTITUTE AN ENDORSEMENT OF EPA.

TOLERANCES			
2 PLCS	3 PLCS	FRAC.	ANGLE
+/- 0.010	+/- 0.005	+/- 1/64	+/- 15'

ALL DIMENSIONS ARE INCHES

FIGURE L-21. 2.5-MICRON IMPACTOR HOUSING, UPPER

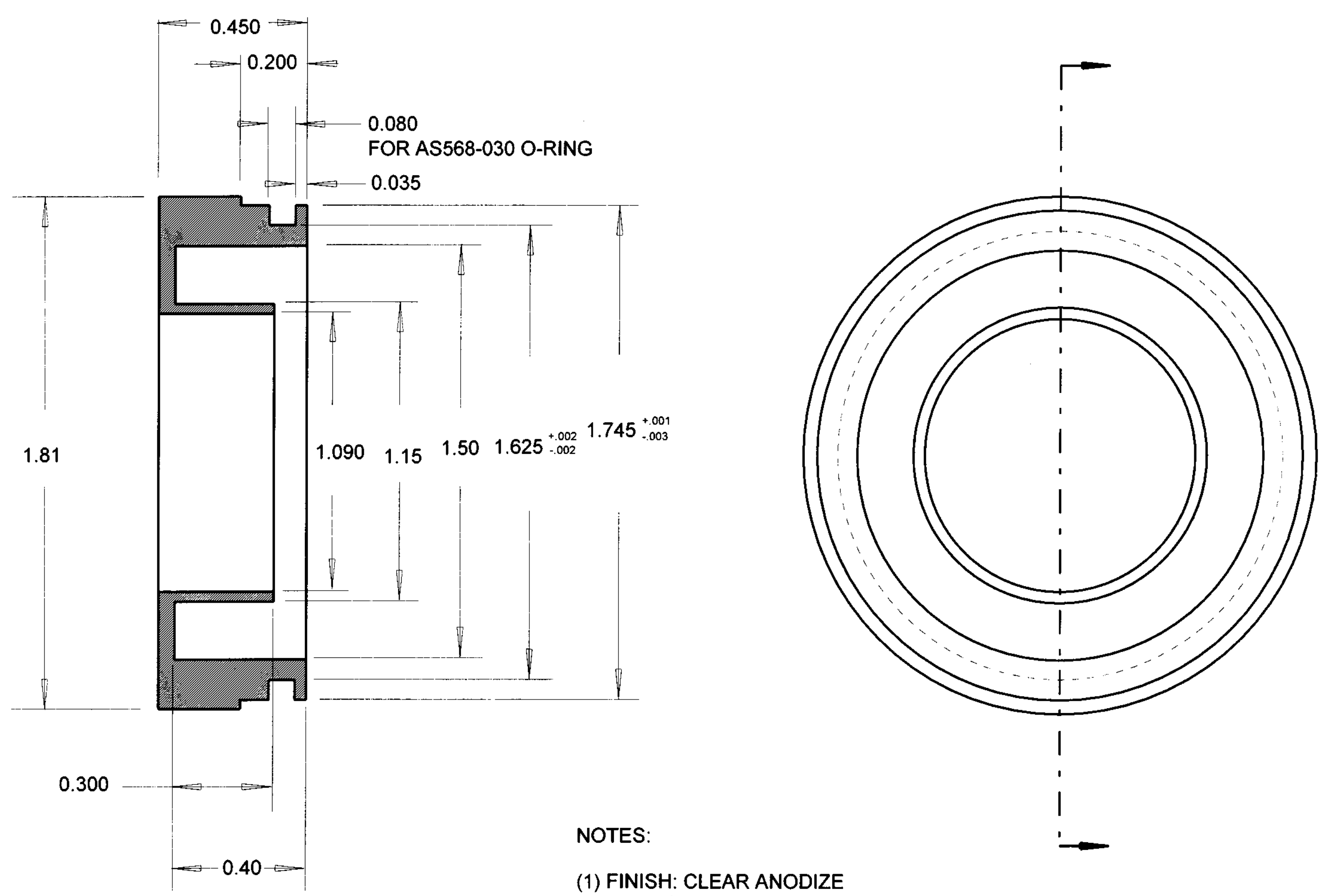


NOTES:

(1) CLEAR ANODIZE
(2) 32 RMS FINISH ALL OVER
(3) 0.152 PIN TO GO COMPLETELY THROUGH, 0.156 PIN NOT TO GO FROM EITHER END
(4) BOXED DIMENSIONS ARE OPTIONAL
(5) MATERIAL IS ALUMINUM 6061-T6
(6) CENTER NOZZLE MAY BE MACHINED SEPARATELY AND ATTACHED USING SCREW THREADS OR PRESS FIT; ALL INTERIOR SURFACES MUST BE AS SHOWN

TOLERANCES				
2 PLCS	3 PLCS	FRAC.	ANGLE	ALL DIMENSIONS ARE INCHES
+/- 0.010	+/- 0.005	+/- 1/64	+/- 15'	

FIGURE L-22. 2.5-MICRON IMPACTOR WELL, UPPER SECTION

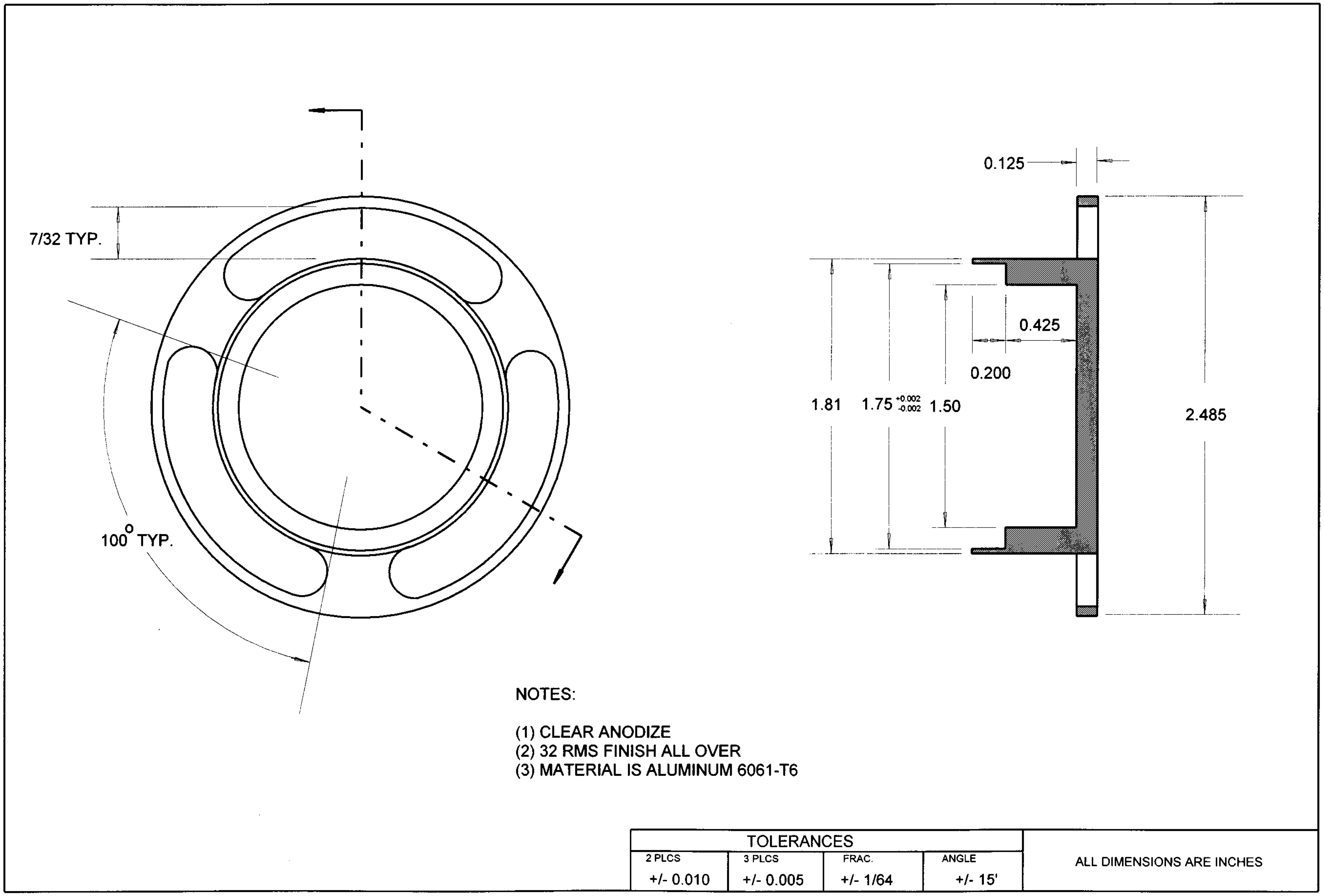


NOTES:

(1) FINISH: CLEAR ANODIZE
(2) 32 RMS FINISH ALL OVER
(3) MATERIAL IS ALUMINUM 6061-T6

TOLERANCES				
2 PLCS	3 PLCS	FRAC.	ANGLE	ALL DIMENSIONS ARE INCHES
+/- 0.010	+/- 0.005	+/- 1/64	+/- 15'	

FIGURE L-23. 2.5-MICRON IMPACTOR WELL, LOWER SECTION



IGURE L-24. 2.5-MICRON IMPACTOR HOUSING, LOWER

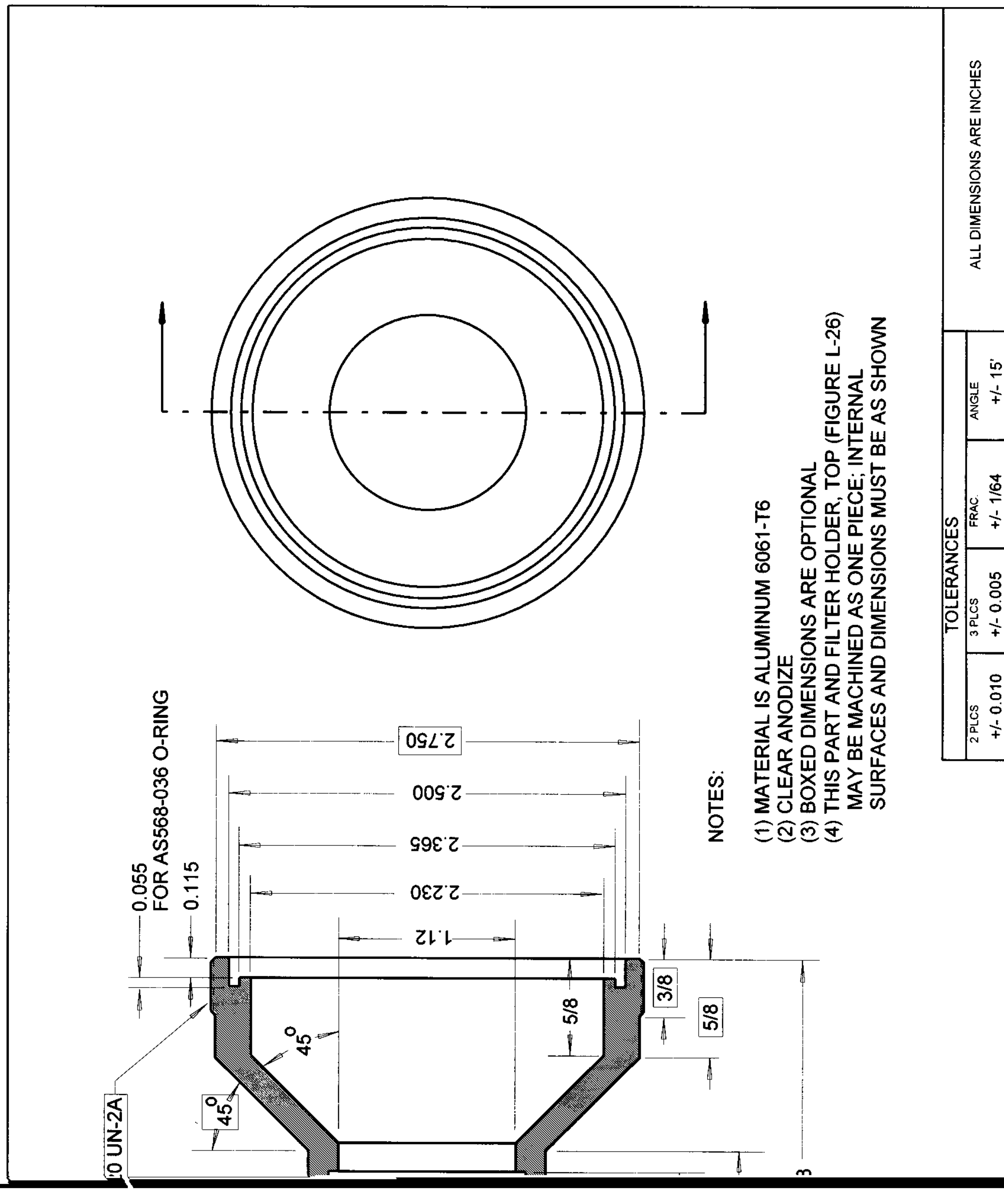
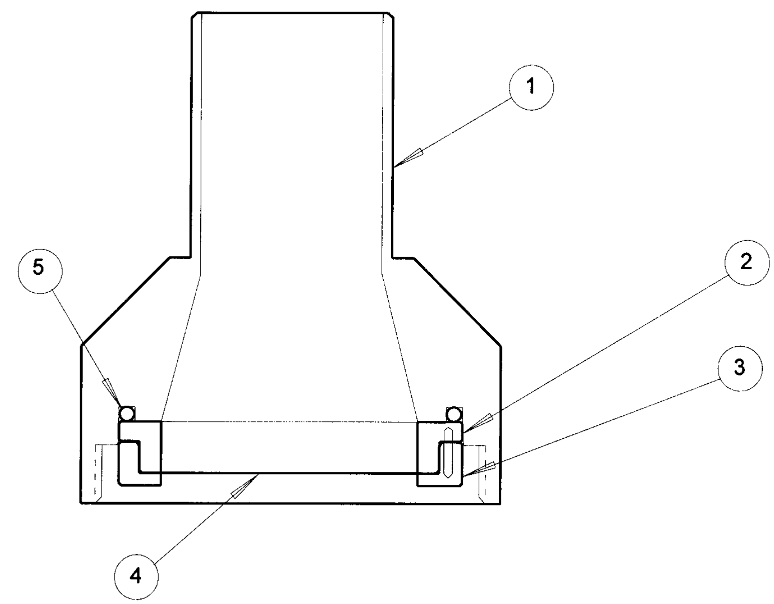


FIGURE L-25. FILTER HOLDER, ASSEMBLY

ITEM	DESCRIPTION	QTY.
1	FILTER HOLDER, TOP (FIGURE L-26)	1
2	FILTER CASSETTE, UPPER (FIGURE L-27)	1
3	FILTER CASSETTE, LOWER (FIGURE L-29)	1
4	FILTER SCREEN (FIGURE L-28) AND FILTER	1
5	O-RING: AS568-135	1



TOLERANCES				
2 PLCS	3 PLCS	FRAC.	ANGLE	ALL DIMENSIONS ARE INCHES
+/- 0.010	+/- 0.005	+/- 1/64	+/- 15'	

FIGURE L-26. FILTER HOLDER, TOP

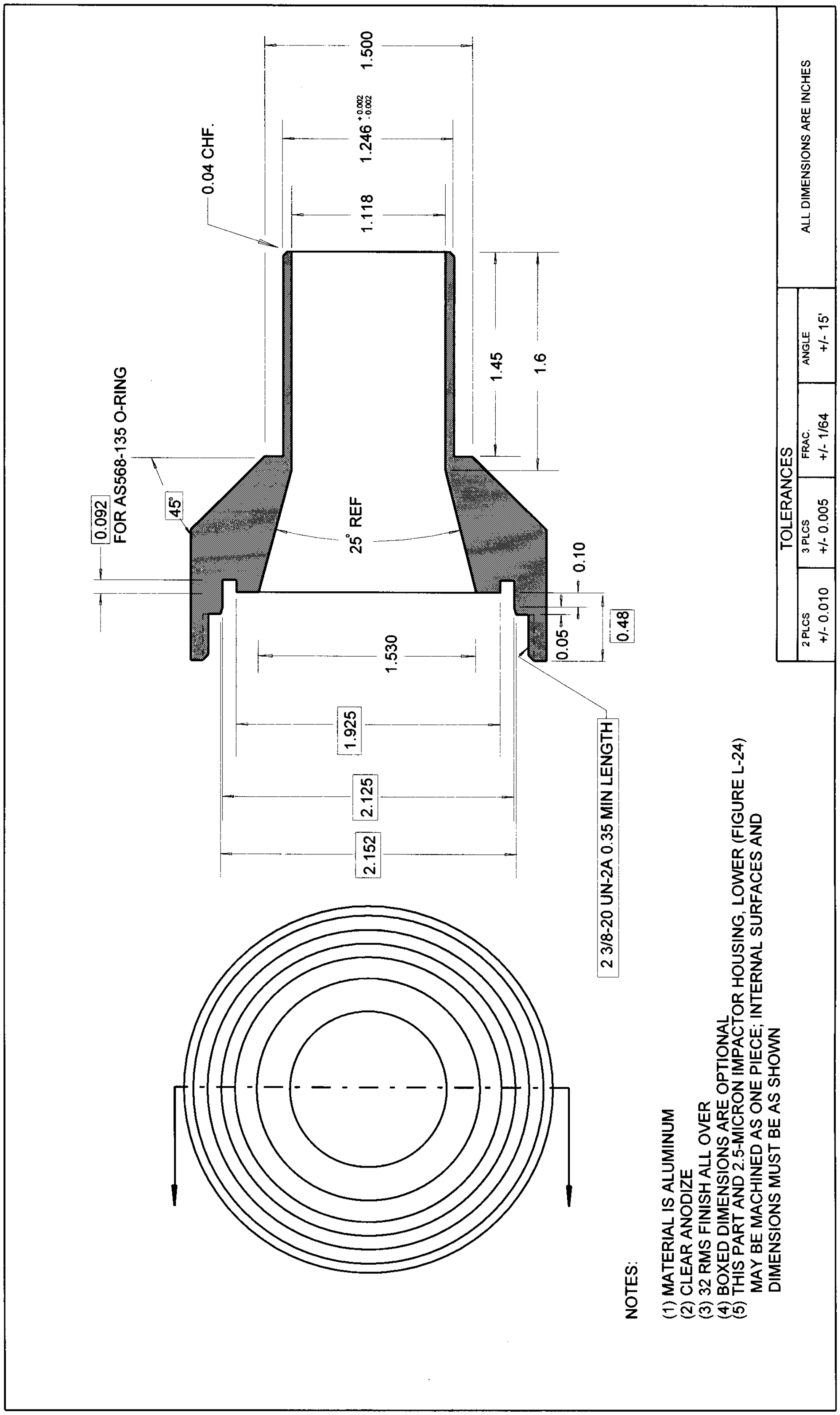


FIGURE L-27. FILTER CASSETTE, UPPER SECTION

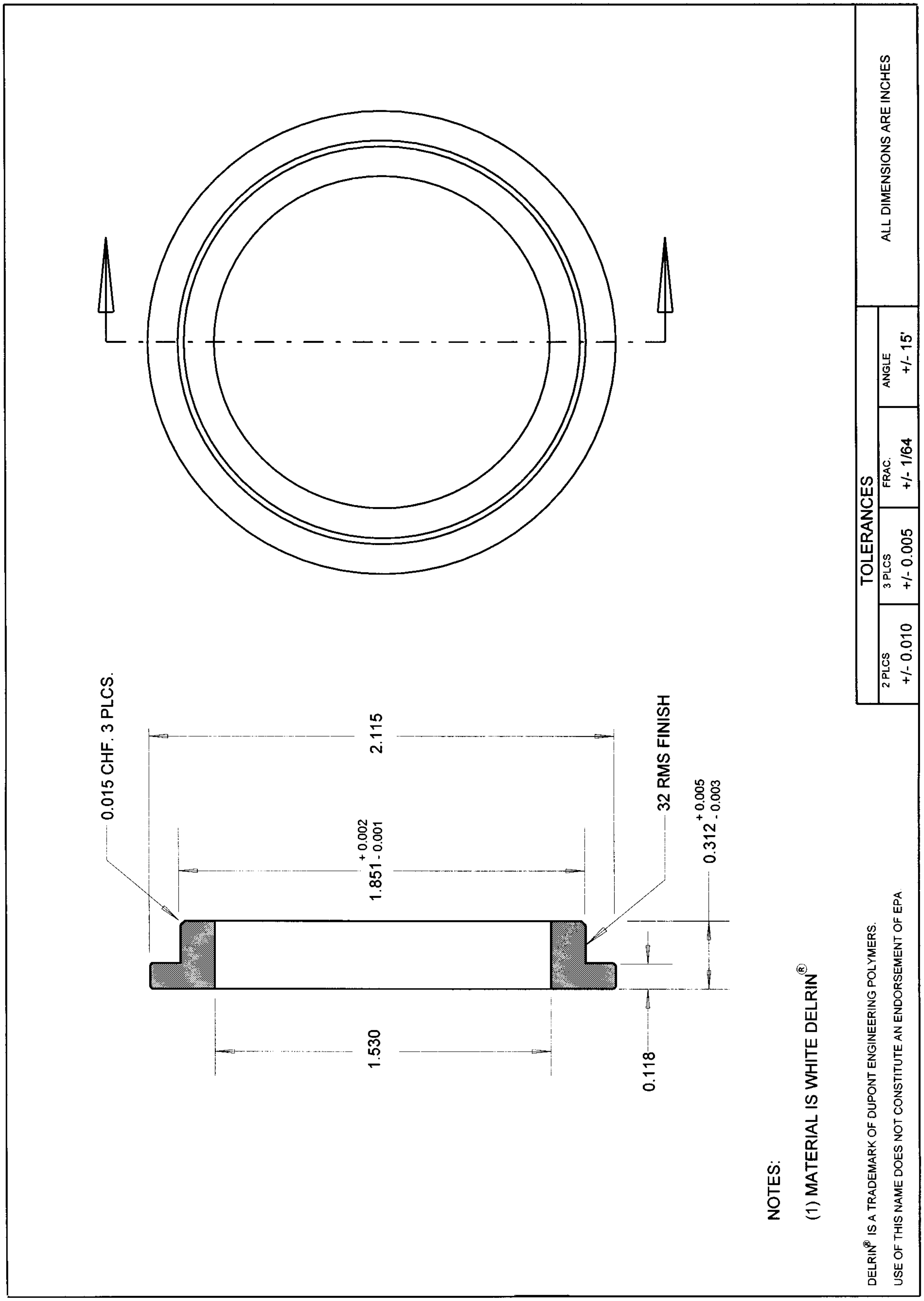


FIGURE L-28. FILTER SCREEN

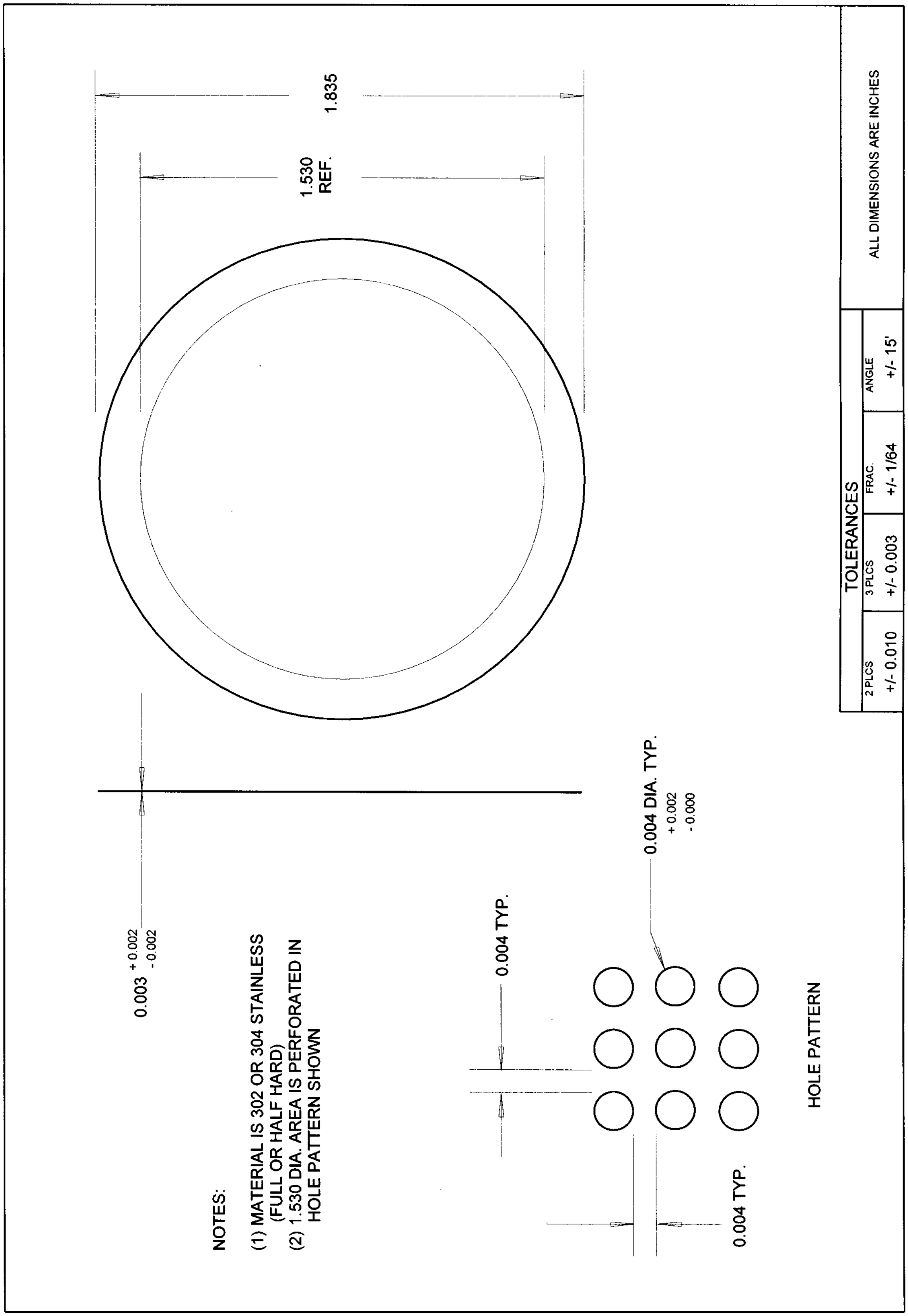


FIGURE L-29. FILTER CASSETTE, LOWER SECTION

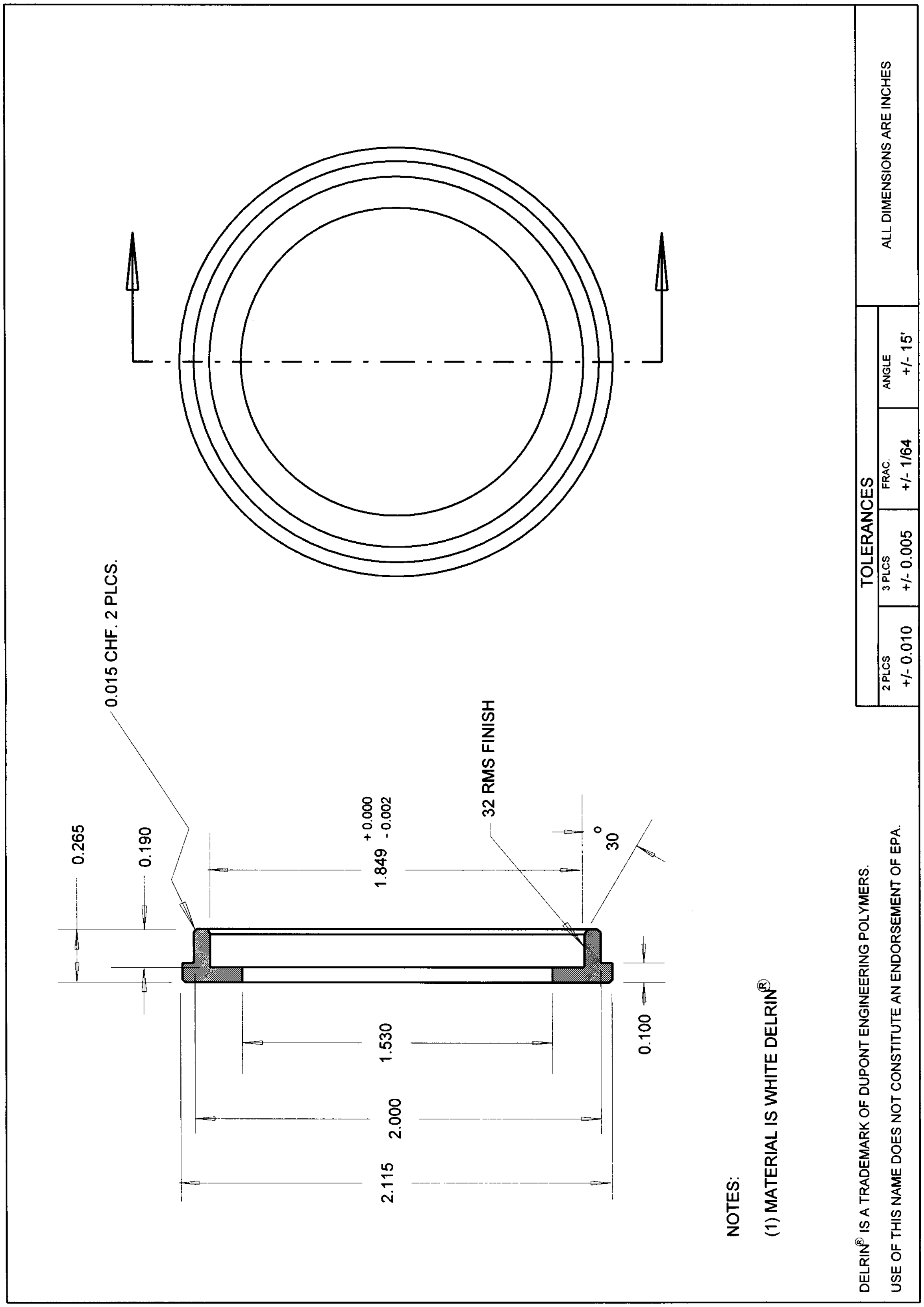
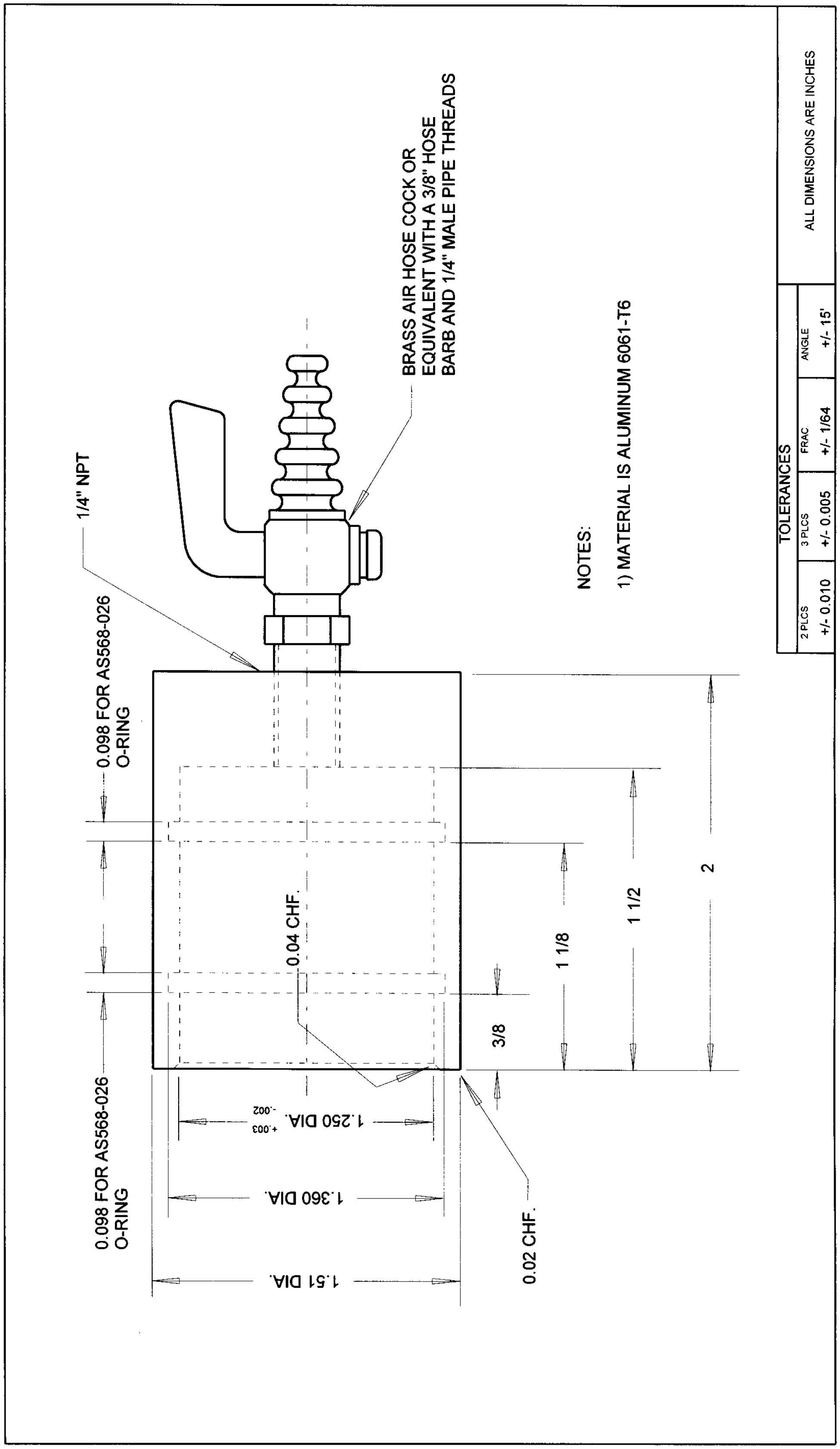


FIGURE L-30. FLOW RATE MEASUREMENT ADAPTER



Appendix 5

Supplementary Material for Chapter 5

Part E
40CFR, Part 53, Subpart E

The accuracy of flow rate meters shall be verified at the highest and lowest pressures and temperatures used in the tests and shall be checked at zero and at least one flow rate within ±3 percent of 16.7 L/min within 7 days prior to use for this test. Where an instrument's measurements are to be recorded with an analog recording device, the accuracy of the entire instrument-recorder system shall be calibrated or verified.

(e) *Test setup*. (1) The candidate test sampler shall have its inlet and impactor or impactors removed. The lower end of the down tube shall be reconnected to the filter holder, using an extension of the downtube, if necessary. If the candidate sampler has a separate impactor for each channel, then for this test, the filter holder assemblies must be connected to the physical location on the sampler where the impactors would normally connect.

(2) The test particle delivery system shall be connected to the sampler downtube so that the test aerosol is introduced at the top of the downtube.

(f) *Test procedure*. (1) All surfaces of the added or modified component or components which come in contact with the aerosol flow shall be thoroughly washed with 0.01 N NaOH and then dried.

(2) Generate aerosol. (i) Generate aerosol composed of oleic acid with a uranine fluorometric tag of 3 ± 0.25 µm aerodynamic diameter using a vibrating orifice aerosol generator according to conventions specified in § 53.61(g).

(ii) Check for the presence of satellites and adjust the generator to minimize their production.

(iii) Calculate the aerodynamic particle size using the operating parameters of the vibrating orifice aerosol generator. The calculated aerodynamic diameter must be 3 ± 0.25 µm aerodynamic diameter.

(3) Verify the particle size according to procedures specified in § 53.62(d)(4)(i).

(4) Collect particles on filters for a time period such that the relative error of the resulting measured fluorometric concentration for the active filter is less than 5 percent.

(5) Determine the quantity of material collected on the active filter using a calibrated fluorometer. Record the mass of fluorometric material for the active filter as $M_{active\ (i)}$ where i = the active channel number.

(6) Determine the quantity of material collected on each no-flow filter using a calibrated fluorometer. Record the mass of fluorometric material on each no-flow filter as $M_{no\text{-}flow}$.

(7) Using 0.01 N NaOH, wash the surfaces of the added component or components which contact the aerosol flow. Determine the quantity of material collected using a calibrated fluorometer. Record the mass of fluorometric material collected in the wash as M_{wash}.

(8) Calculate the aerosol transport as:

Equation 29

$$T_{(i)} = \frac{M_{active}}{M_{active+}M_{wash+}\sum M_{no\text{-}flow}} \text{ x } 100\%$$

where:

i = the active channel number.

(9) Repeat paragraphs (f)(1) through (8) of this section for each channel, making each channel in turn the exclusive active channel.

(g) *Test results*. The candidate Class I sampler passes the aerosol transport test if $T_{(i)}$ is at least 97 percent for each channel.

Tables to Subpart E of Part 53

Table E-1.—Summary of Test Requirements for Reference and Class I Equivalent Methods for $PM_{2.5}$

Subpart E Procedure	Performance Test	Performance Specification	Test Conditions	Part 50, Appendix L Reference
§ 53.52 Sampler leak check test	Sampler leak check facility	External leakage: 80 mL/min, max Internal leakage: 80 mL/min, max	Controlled leak flow rate of 80 mL/min	Sec. 7.4.6
§ 53.53 Base flow rate test	Sample flow rate: 1. Mean 2. Regulation 3. Meas. accuracy 4. CV accuracy 5. Cut-off	1. 16.67 ± 5%, L/min 2. 2%, max 3. 2%, max 4. 0.3%, max 5. Flow rate cut-off if flow rate deviates more than 10% from design flow rate for >60 ± 30 seconds	(a) 6-hour normal operational test plus flow rate cut-off test (b) Nominal conditions (c) Additional 55 mm Hg pressure drop to simulate loaded filter (d) Variable flow restriction used for cut-off test	Sec. 7.4.1 Sec. 7.4.2 Sec. 7.4.3 Sec. 7.4.4 Sec. 7.4.5
§ 53.54 Power interruption test	Sample flow rate: 1. Mean 2. Regulation 3. Meas. accuracy 4. CV accuracy 5. Occurrence time of power interruptions 6. Elapsed sample time 7. Sample volume	1. 16.67 ± 5%, L/min 2. 2%, max 3. 2%, max 4. 0.3%, max 5. ±2 min if >60 seconds 6. ±20 seconds 7. ±2%, max	(a) 6-hour normal operational test (b) Nominal conditions (c) Additional 55 mm Hg pressure drop to simulate loaded filter (d) 6 power interruptions of various durations	Sec. 7.4.1 Sec. 7.4.2 Sec. 7.4.3 Sec. 7.4.5 Sec. 7.4.12 Sec. 7.4.13 Sec. 7.4.15.4 Sec. 7.4.15.5
§ 53.55 Temperature and line voltage effect test	Sample flow rate: 1. Mean 2. Regulation 3. Meas. accuracy 4. CV accuracy 5. Temperature meas. accuracy 6. Proper operation	1. 16.67 ± 5%, L/min 2. 2 %, max 3. 2 %, max 4. 0.3 %, max 5. 2 °C	(a) 6-hour normal operational test (b) Nominal conditions (c) Additional 55 mm Hg pressure drop to simulate loaded filter (d) Ambient temperature at -20 and +40 °C (e) Line voltage: 105 Vac to 125 Vac	Sec. 7.4.1 Sec. 7.4.2 Sec. 7.4.3 Sec. 7.4.5 Sec. 7.4.8 Sec. 7.4.15.1

Table E-1.—Summary of Test Requirements for Reference and Class I Equivalent Methods for $PM_{2.5}$—Continued

Subpart E Procedure	Performance Test	Performance Specification	Test Conditions	Part 50, Appendix L Reference
§ 53.56 Barometric pressure effect test	Sample flow rate: 1. Mean 2. Regulation 3. Meas. accuracy 4. CV accuracy 5. Pressure meas. accuracy 6. Proper operation	1. 16.67 ± 5%, L/min 2. 2%, max 3. 2%, max 4. 0.3%, max 5. 10 mm Hg	(a) 6-hour normal operational test (b) Nominal conditions (c) Additional 55 mm Hg pressure drop to simulate loaded filter (d) Barometric pressure at 600 and 800 mm Hg.	Sec. 7.4.1 Sec. 7.4.2 Sec. 7.4.3 Sec. 7.4.5 Sec. 7.4.9
§ 53.57 Filter temperature control test	1. Filter temp meas. accuracy 2. Ambient temp. meas. accuracy 3. Filter temp control accuracy, sampling and non-sampling	1. 2 °C 2. 2 °C 3. Not more than 5 °C above ambient temp. for more than 30 min	(a) 4-hour simulated solar radiation, sampling (b) 4-hour simulated solar radiation, non-sampling (c) Solar flux of 1000 W/m^2	Sec. 7.4.8 Sec. 7.4.10 Sec. 7.4.11
§ 53.58 Field precision test	1. Measurement precision 2. Storage deposition test for sequential samplers	1. P_j <2 $\mu g/m^3$ for conc. <40 $\mu g/m^3$ (24-hr) or <30 $\mu g/m^3$ (48-hr); or RP_j < 5% for conc. >40 µg/m3 (24-hr) or >30 µg/m3 (48-hr) 2. 50 µg, max weight gain	(a) 3 collocated samplers at 1 site for at least 10 days (b) $PM_{2.5}$ conc.≤10 $\mu g/m^3$ (c) 24- or 48-hour samples (d) 5- or 10-day storage period for inactive stored filters	Sec. 5.1 Sec. 7.3.5 Sec. 8 Sec. 9 Sec. 10
The Following Requirement is Applicable to Candidate Equivalent Methods Only				
§ 53.59 Aerosol transport test	Aerosol transport	97%, min, for all channels	Determine aerosol transport through any new or modified components with respect to the reference method sampler before the filter for each channel.	

TABLE E-2.—SPECTRAL ENERGY DISTRIBUTION AND PERMITTED TOLERANCE FOR CONDUCTING RADIATIVE TESTS

Chacteristic	Spectral Region			
	Ultraviolet		Visible	Infrared
Bandwidth (µm)	0.28 to 0.32	10.32 to 0.40	0.40 to 0.78	0.78 to 3.00
Irradiance (W/m^2)	5	56	450 to 550	439
Allowed Tolerance	2± 35%	2± 25%	2± 10%	2± 10%

Figures to Subpart E of Part 53

Figure E-1.—Designation Testing Checklist

DESIGNATION TESTING CHECKLIST

Auditee	Auditor signature	Date
______________	______________	______________

Compliance Status: Y = Yes N = No NA = Not applicable/Not available				Verification Comments (Includes documentation of who, what, where, when, why) (Doc. #, Rev. #, Rev. Date)
Verification			Verified by Direct Observation of Process or of Documented Evidence: Performance, Design or Application Spec. Corresponding to Sections of 40 CFR Part 53 or 40 CFR Part 50, Appendix L	
Y	N	NA		
			Performance Specification Tests Sample flow rate coefficient of variation (§ 53.53) (L 7.4.3)	
			Filter temperature control (sampling) (§ 53.57) (L 7.4.10)	
			Elapsed sample time accuracy (§ 53.54) (L 7.4.13)	
			Filter temperature control (post sampling) (§ 53.57) (L 7.4.10)	
			Application Specification Tests	
			Field Precision (§ 53.58) (L 5.1)	
			Meets all Appendix L requirements (part 53, subpart A, § 53.2(a)(3)) (part 53, subpart E, § 53.51(a),(d))	
			Filter Weighing (L-8)	
			Field Sampling Procedure (§ 53.30, .31, .34)	
			Design Specification Tests	
			Filter (L-6)	
			Range of Operational Conditions (L-7.4.7)	
The Following Requirements Apply Only to Class I Candidate Equivalent Methods				
			Aerosol Transport (§ 53.59)	

Figure E-2—Product Manufacturing Checklist

PRODUCT MANUFACTURING CHECKLIST

Auditee ______ Auditor signature ______ Date ______

Compliance Status: Y = Yes N = No NA = Not applicable/Not available				Verification Comments (Includes documentation of who, what, where, when, why) (Doc. #, Rev. #, Rev. Date)
Verification			Verified by Direct Observation of Process or of Documented Evidence: Performance, Design or Application Spec. Corresponding to Sections of 40 CFR Part 53 or 40 CFR Part 50, Appendix L	
Y	N	NA		
			Performance Specification Tests	
			Assembled operational performance (Burn-in test) (§ 53.53)	
			Sample flow rate (§ 53.53) (L 7.4.1, L 7.4.2)	
			Sample flow rate regulation (§ 53.53) (L 7.4.3)	
			Flow rate and average flow rate measurement accuracy (§ 53.53) (L 7.4.5)	
			Ambient air temperature measurement accuracy (§ 53.55) (L 7.4.8)	
			Ambient barometric pressure measurement accuracy (§ 53.56) (L 7.4.9)	
			Sample flow rate cut-off (§ 53.53) (L 7.4.4)	
			Sampler leak check facility (§ 53.52) (L 7.4.6)	
			Application Specification Tests	
			Flow rate calibration transfer standard (L-9.2)	
			Operational /Instructional manual (L-7.4.18)	
			Design Specification Tests	
			Impactor (jet width) (§ 53.51(d)(1)) (L-7.3.4.1)	
			Surface finish (§ 53.51(d)(2)) (L-7.3.7)	

Appendix A to Subpart E of Part 53--References

(1) Quality systems--Model for quality assurance in design, development, production, installation and servicing, ISO 9001. July 1994. Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

(2) American National Standard--Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs. ANSI/ASQC E4-1994. January 1995. Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

(3) Copies of section 2.12 of the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods, EPA/600/R-94/038b, are available from Department E (MD-77B), U.S. EPA, Research Triangle Park, NC 27711.

(4) Military standard specification (mil. spec.) 8625F, Type II, Class 1 as listed in Department of Defense Index of Specifications and Standards (DODISS), available from DODSSP-Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 1911-5094.

(5) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements. Revised March, 1995. EPA-600/R-94-038d. Available from U.S. EPA, ORD Publications Office, Center for Environmental Research Information (CERI), 26 West Martin Luther King Drive, Cincinnati, Ohio 45268-1072 (513-569-7562).

(6) Military standard specification (mil. spec.) 810-E as listed in Department of Defense Index of Specifications and Standards (DODISS), available from DODSSP-Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 1911-5094.

e. Subpart F is added to read as follows:

Subpart F—Procedures for Testing Performance Characteristics of Class II Equivalent Methods for $PM_{2.5}$

Sec.

Tables to Subpart F of Part 53

Figures to Subpart F of Part 53

Appendix A to Subpart F of Part 53—References

Subpart F—Procedures for Testing Performance Characteristics of Class II Equivalent Methods for $PM_{2.5}$

§ 53.60 General provisions.

(a) This subpart sets forth the specific requirements that a $PM_{2.5}$ sampler associated with a candidate Class II equivalent method must meet to be designated as an equivalent method for $PM_{2.5}$. This subpart also sets forth the explicit test procedures that must be carried out and the test results, evidence, documentation, and other materials that must be provided to EPA to demonstrate that a sampler meets all specified requirements for designation as an equivalent method.

(b) A candidate method described in an application for a reference or equivalent method application submitted under § 53.4 shall be determined by the EPA to be a Class II candidate equivalent method on the basis of the definition of a Class II equivalent method given in § 53.1.

(c) Any sampler associated with a Class II candidate equivalent method (Class II sampler) must meet all requirements for reference method samplers and Class I equivalent method samplers specified in subpart E of this part, as appropriate. In addition, a Class II sampler must meet the additional requirements as specified in paragraph (d) of this section.

(d) Except as provided in paragraphs (d)(1), (2), and (3) of this section, all Class II samplers are subject to the additional tests and performance requirements specified in § 53.62 (full wind tunnel test), § 53.65 (loading test), and § 53.66 (volatility test). Alternative tests and performance requirements, as described in paragraphs (d)(1), (2), and (3) of this section, are optionally available for certain Class II samplers which meet the requirements for reference method or Class I samplers given in 40 CFR part 50, Appendix L, and in subpart E of this part, except for specific deviations of the inlet, fractionator, or filter.

(1) *Inlet deviation*. A sampler which has been determined to be a Class II sampler solely because the design or construction of its inlet deviates from the design or construction of the inlet specified in 40 CFR part 50, Appendix L, for reference method samplers shall not be subject to the requirements of § 53.62 (full wind tunnel test), provided that it meets all requirements of § 53.63 (wind tunnel inlet aspiration test), § 53.65 (loading test), and § 53.66 (volatility test).

(2) *Fractionator deviation*. A sampler which has been determined to be a Class II sampler solely because the design or construction of its particle size fractionator deviates from the design or construction of the particle size fractionator specified in 40 CFR part 50, Appendix L for reference method samplers shall not be subject to the requirements of § 53.62 (full wind tunnel test), provided that it meets all requirements of § 53.64 (static fractionator test), § 53.65 (loading test), and § 53.66 (volatility test).

(3) *Filter size deviation*. A sampler which has been determined to be a Class II sampler solely because its effective filtration area deviates from that of the reference method filter specified in 40 CFR part 50, Appendix L, for reference method samplers shall not be subject to the requirements of § 53.62 (full wind tunnel test) nor § 53.65 (loading test), provided it meets all requirements of § 53.66 (volatility test).

(e) *The test specifications and acceptance criteria for each test are summarized in Table F-1 of this subpart*. The candidate sampler must demonstrate performance that meets the acceptance criteria for each applicable test to be designated as an equivalent method.

(f) *Overview of various test procedures for Class II samplers*—(1) *Full wind tunnel test*. This test procedure is designed to ensure that the candidate sampler's effectiveness (aspiration of an ambient aerosol and penetration of the sub 2.5-micron fraction to its sample filter) will be comparable to that of a reference method sampler. The candidate sampler is challenged at wind speeds of 2 and 24 km/hr with monodisperse aerosols of the size specified in Table F-2 of this subpart. The experimental test results are then integrated with three idealized ambient distributions (typical, fine, and coarse) to yield the expected mass concentration measurement for each. The acceptance criteria are based on the results of this numerical analysis and the particle diameter for which the sampler effectiveness is 50 percent.

(2) *Wind tunnel inlet aspiration test*. The wind tunnel inlet aspiration test directly compares the inlet of the candidate sampler to the inlet of a reference method sampler with the single-sized, liquid, monodisperse challenge aerosol specified in Table F-2 of this subpart at wind speeds of 2 km/hr and 24 km/hr. The acceptance criteria, presented in Table F-1 of this subpart, is based on the relative aspiration between the candidate inlet and the reference method inlet.

(3) *Static fractionator test*. The static fractionator test determines the effectiveness of the candidate sampler's 2.5-micron fractionator under static conditions for aerosols of the size specified in Table F-2 of this subpart. The numerical analysis procedures and acceptance criteria are identical to those in the full wind tunnel test.

(4) *Loading test*. The loading test is conducted to ensure that the performance of a candidate sampler is not significantly affected by the amount of particulate deposited on its interior surfaces between periodic cleanings. The candidate sampler is artificially loaded by sampling a test

Appendix 5

Supplementary Material for Chapter 5

Part F

Appendix A to 40CFR, Part 58

(c) Each $PM_{2.5}$ station in the SLAMS network must be in operation in accordance with the minimum requirements of Appendix D of this part, be sited in accordance with the criteria in Appendix E of this part, and be located as described on the station's AIRS site identification form, according to the following schedule:

(1) Within 1 year after September 16, 1997, at least one required core $PM_{2.5}$ SLAMS site in each MSA with population greater than 500,000, plus one site in each PAMS area, (plus at least two additional SLAMS sites per State) must be in operation.

(2) Within 2 years after September 16, 1997, all other required SLAMS, including all required core SLAMS, required regional background and regional transport SLAMS, continuous PM monitors in areas with greater than 1 million population, and all additional required $PM_{2.5}$ SLAMS must be in operation.

(3) Within 3 years after September 16, 1997, all additional sites (e.g., sites classified as SLAMS/SPM to complete the mature network) must be in operation.

g. Section 58.26 is amended by revising the section heading and the introductory text of paragraph (b), and adding paragraphs (d) and (e) to read as follows:

§ 58.26 Annual state air monitoring report.

* * * * *

(b) The SLAMS annual data summary report must contain:

* * * * *

(d) For PM monitoring and data—(1) The State shall submit a summary to the appropriate Regional Office (for SLAMS) or Administrator (through the Regional Office) (for NAMS) that details proposed changes to the PM Monitoring Network Description and to be in accordance with the annual network review requirements in § 58.25. This shall discuss the existing PM networks, including modifications to the number, size or boundaries of monitoring planning areas and optional community monitoring zones; number and location of PM_{10} and $PM_{2.5}$ SLAMS; number and location of core $PM_{2.5}$ SLAMS; alternative sampling frequencies proposed for $PM_{2.5}$ SLAMS (including core $PM_{2.5}$ SLAMS and $PM_{2.5}$ NAMS), core $PM_{2.5}$ SLAMS to be designated $PM_{2.5}$ NAMS; and PM_{10} and $PM_{2.5}$ SLAMS to be designated PM_{10} and $PM_{2.5}$ NAMS respectively.

(2) The State shall submit an annual summary to the appropriate Regional Office of all the ambient air quality monitoring PM data from all special purpose monitors that are described in the State's PM monitoring network description and are intended for SIP purposes. These include those population-oriented SPMs that are eligible for comparison to the PM NAAQS. The State shall certify the data in accordance with paragraph (c) of this section.

(e) The Annual State Air Monitoring Report shall be submitted to the Regional Administrator by July 1 or by an alternative annual date to be negotiated between the State and Regional Administrator. The Region shall provide review and approval/disapproval within 60 days. After 3 years following September 16, 1997, the schedule for submitting the required annual revised $PM_{2.5}$ monitoring network description may be altered based on a new schedule determined by the Regional Administrator. States may submit an alternative PM monitoring network description in which it requests exemptions from specific required elements of the network design (e.g., required number of core sites, other SLAMS, sampling frequency, etc.). After 3 years following September 16, 1997 or once a CMZ monitoring area has been determined to violate the NAAQS, then changes to an MPA monitoring network affecting the violating locations shall require public review and notification.

h. Section 58.30 is amended by revising the introductory text of paragraph (a) to read as follows:

§ 58.30 NAMS network establishment.

(a) By January 1, 1980, with the exception of PM_{10} and $PM_{2.5}$ samplers, which shall be by July 1, 1998, the State shall:

* * * * *

i. In § 58.31, paragraph (f) is revised to read as follows:

§ 58.31 NAMS network description.

* * * * *

(f) The monitoring objective, spatial scale of representativeness, and for $PM_{2.5}$, the monitoring planning area and community monitoring zone, as defined in Appendix D of this part.

* * * * *

j. In § 58.34, the introductory text is revised to read as follows:

§ 58.34 NAMS network completion.

With the exception of PM_{10} samplers, which shall be by 1 year after September 16, 1997, and $PM_{2.5}$, which shall be by 3 years after September 16, 1997:

* * * * *

k. In § 58.35, the first sentence of paragraph (b) is revised to read as follows:

§ 58.35 NAMS data submittal.

* * * * *

(b) The State shall report to the Administrator all ambient air quality data for SO^2, CO, O_3, NO_2, Pb, PM_{10}, and $PM_{2.5}$, and information specified by the AIRS Users Guide (Volume II, Air Quality Data Coding, and Volume III, Air Quality Data Storage) to be coded into the AIRS-AQS format. * * *

* * * * *

l. Revise Appendix A of part 58 to read as follows:

Appendix A—Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)

1. *General Information*.

1.1 This Appendix specifies the minimum quality assurance/quality control (QA/QC) requirements applicable to SLAMS air monitoring data submitted to EPA. State and local agencies are encouraged to develop and maintain quality assurance programs more extensive than the required minimum.

1.2 To assure the quality of data from air monitoring measurements, two distinct and important interrelated functions must be performed. One function is the control of the measurement process through broad quality assurance activities, such as establishing policies and procedures, developing data quality objectives, assigning roles and responsibilities, conducting oversight and reviews, and implementing corrective actions. The other function is the control of the measurement process through the implementation of specific quality control procedures, such as audits, calibrations, checks, replicates, routine self-assessments, etc. In general, the greater the control of a given monitoring system, the better will be the resulting quality of the monitoring data. The results of quality assurance reviews and assessments indicate whether the control efforts are adequate or need to be improved.

1.3 Documentation of all quality assurance and quality control efforts implemented during the data collection, analysis, and reporting phases is important to data users, who can then consider the impact of these control efforts on the data quality (see Reference 1 of this Appendix). Both qualitative and quantitative assessments of the effectiveness of these control efforts should identify those areas most likely to impact the data quality and to what extent.

1.4 Periodic assessments of SLAMS data quality are required to be reported to EPA. To provide national uniformity in this assessment and reporting of data quality for all SLAMS networks, specific assessment and reporting procedures are prescribed in detail in sections 3, 4, and 5 of this Appendix. On the other hand, the selection and extent of the QA and QC activities used by a monitoring agency depend on a number of local factors such as the field and laboratory conditions, the objectives for monitoring, the level of the data quality needed, the expertise of assigned personnel, the cost of control procedures, pollutant concentration levels, etc. Therefore, the quality system requirements, in section 2 of this Appendix, are specified in general terms to allow each State to develop a quality assurance program that is most efficient and effective for its own circumstances while achieving the Ambient Air Quality Programs data quality objectives.

2. *Quality System Requirements*.

2.1 Each State and local agency must develop a quality system (Reference 2 of this Appendix) to ensure that the monitoring results:

(a) Meet a well-defined need, use, or purpose.

(b) Satisfy customers' expectations.

(c) Comply with applicable standards specifications.

(d) Comply with statutory (and other) requirements of society.

(e) Reflect consideration of cost and economics.

(f) Implement a quality assurance program consisting of policies, procedures, specifications, standards, and documentation necessary to:

(1) Provide data of adequate quality to meet monitoring objectives, and

(2) Minimize loss of air quality data due to malfunctions or out-of-control conditions. This quality assurance program must be described in detail, suitably documented in accordance with

Agency requirements (Reference 4 of this Appendix), and approved by the appropriate Regional Administrator, or the Regional Administrator's designee. The Quality Assurance Program will be reviewed during the systems audits described in section 2.5 of this Appendix.

2.2 Primary requirements and guidance documents for developing the quality assurance program are contained in References 2 through 7 of this Appendix, which also contain many suggested and required procedures, checks, and control specifications. Reference 7 of this Appendix describes specific guidance for the development of a QA Program for SLAMS. Many specific quality control checks and specifications for methods are included in the respective reference methods described in part 50 of this chapter or in the respective equivalent method descriptions available from EPA (Reference 8 of this Appendix). Similarly, quality control procedures related to specifically designated reference and equivalent method analyzers are contained in the respective operation or instruction manuals associated with those analyzers. Quality assurance guidance for meteorological systems at PAMS is contained in Reference 9 of this Appendix. Quality assurance procedures for VOC, NO_x (including NO and NO_2), O_3, and carbonyl measurements at PAMS must be consistent with Reference 15 of this Appendix. Reference 4 of this Appendix includes requirements for the development of quality assurance project plans, and quality assurance and control programs, and systems audits demonstrating attainment of the requirements.

2.3 Pollutant Concentration and Flow Rate Standards.

2.3.1 Gaseous pollutant concentration standards (permeation devices or cylinders of compressed gas) used to obtain test concentrations for CO, SO_2, NO, and NO_2 must be traceable to either a National Institute of Standards and Technology (NIST) NIST-Traceable Reference Material (NTRM) or a NIST-certified Gas Manufacturer's Internal Standard (GMIS), certified in accordance with one of the procedures given in Reference 10 of this Appendix.

2.3.2 Test concentrations for O_3 must be obtained in accordance with the UV photometric calibration procedure specified in 40 CFR part 50, Appendix D, or by means of a certified ozone transfer standard. Consult References 11 and 12 of this Appendix for guidance on primary and transfer standards for O_3.

2.3.3 Flow rate measurements must be made by a flow measuring instrument that is traceable to an authoritative volume or other applicable standard. Guidance for certifying some types of flowmeters is provided in Reference 7 of this Appendix.

2.4 National Performance Audit Program (NPAP). Agencies operating SLAMS are required to participate in EPA's NPAP. These audits are described in Reference 7 of this Appendix. For further instructions, agencies should contact either the appropriate EPA Regional QA Coordinator at the appropriate EPA Regional Office location, or the NPAP Coordinator, Emissions Monitoring and Analysis Division (MD–14), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

2.5 Systems Audit Programs. Systems audits of the ambient air monitoring programs of agencies operating SLAMS shall be conducted at least every 3 years by the appropriate EPA Regional Office. Systems audit programs are described in Reference 7 of this Appendix. For further instructions, agencies should contact either the appropriate EPA Regional QA Coordinator or the Systems Audit QA Coordinator, Office of Air Quality Planning and Standards, Emissions Monitoring and Analysis Division (MD-14), U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

3. *Data Quality Assessment Requirements*.

3.0.1 All ambient monitoring methods or analyzers used in SLAMS shall be tested periodically, as described in this section, to quantitatively assess the quality of the SLAMS data. Measurement uncertainty is estimated for both automated and manual methods. Terminology associated with measurement uncertainty are found within this Appendix and includes:

(a) Precision. A measurement of mutual agreement among individual measurements of the same property usually under prescribed similar conditions, expressed generally in terms of the standard deviation;

(b) Accuracy. The degree of agreement between an observed value and an accepted reference value, accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations;

(c) Bias. The systematic or persistent distortion of a measurement process which causes errors in one direction. The individual results of these tests for each method or analyzer shall be reported to EPA as specified in section 4 of this Appendix. EPA will then calculate quarterly assessments of measurement uncertainty applicable to the SLAMS data as described in section 5 of this Appendix. Data assessment results should be reported to EPA only for methods and analyzers approved for use in SLAMS monitoring under Appendix C of this part.

3.0.2 Estimates of the data quality will be calculated on the basis of single monitors and reporting organizations and may also be calculated for each region and for the entire Nation. A reporting organization is defined as a State, subordinate organization within a State, or other organization that is responsible for a set of stations that monitors the same pollutant and for which data quality assessments can be pooled. States must define one or more reporting organizations for each pollutant such that each monitoring station in the State SLAMS network is included in one, and only one, reporting organization.

3.0.3 Each reporting organization shall be defined such that measurement uncertainty among all stations in the organization can be expected to be reasonably homogeneous, as a result of common factors.

(a) Common factors that should be considered by States in defining reporting organizations include:

(1) Operation by a common team of field operators.

(2) Common calibration facilities.

(3) Oversight by a common quality assurance organization.

(4) Support by a common laboratory or headquarters.

(b) Where there is uncertainty in defining the reporting organizations or in assigning specific sites to reporting organizations, States shall consult with the appropriate EPA Regional Office. All definitions of reporting organizations shall be subject to final approval by the appropriate EPA Regional Office.

3.0.4 Assessment results shall be reported as specified in section 4 of this Appendix. Table A-1 of this Appendix provides a summary of the minimum data quality assessment requirements, which are described in more detail in the following sections.

3.1 Precision of Automated Methods Excluding $PM_{2.5}$.

3.1.1 Methods for SO_2, NO_2, O_3 and CO. A one-point precision check must be performed at least once every 2 weeks on each automated analyzer used to measure SO_2, NO_2, O_3 and CO. The precision check is made by challenging the analyzer with a precision check gas of known concentration (effective concentration for open path analyzers) between 0.08 and 0.10 ppm for SO_2, NO_2, and O_3 analyzers, and between 8 and 10 ppm for CO analyzers. To check the precision of SLAMS analyzers operating on ranges higher than 0 to 1.0 ppm SO_2, NO_2, and O_3, or 0 to 100 ppm for CO, use precision check gases of appropriately higher concentration as approved by the appropriate Regional Administrator or their designee. However, the results of precision checks at concentration levels other than those specified above need not be reported to EPA. The standards from which precision check test concentrations are obtained must meet the specifications of section 2.3 of this Appendix.

3.1.1.1 Except for certain CO analyzers described below, point analyzers must operate in their normal sampling mode during the precision check, and the test atmosphere must pass through all filters, scrubbers, conditioners and other components used during normal ambient sampling and as much of the ambient air inlet system as is practicable. If permitted by the associated operation or instruction manual, a CO point analyzer may be temporarily modified during the precision check to reduce vent or purge flows, or the test atmosphere may enter the analyzer at a point other than the normal sample inlet, provided that the analyzer's response is not likely to be altered by these deviations from the normal operational mode. If a precision check is made in conjunction with a zero or span adjustment, it must be made prior to such zero or span adjustments. Randomization of the precision check with respect to time of day, day of week, and routine service and adjustments is encouraged where possible.

3.1.1.2 Open path analyzers are tested by inserting a test cell containing a precision check gas concentration into the optical measurement beam of the instrument. If possible, the normally used transmitter, receiver, and as appropriate, reflecting devices should be used during the test, and the normal monitoring configuration of the instrument should be altered as little as possible to accommodate the test cell for the test. However, if permitted by the associated operation or instruction manual, an alternate local light source or an alternate optical path that does not include the normal atmospheric monitoring path may be used. The actual concentration of the precision check gas in the test cell must be selected to produce an effective concentration in the range specified in section 3.1.1. Generally, the precision test concentration measurement will be the sum of the atmospheric pollutant concentration and the precision test concentration. If so, the result must be corrected to remove the atmospheric concentration contribution. The corrected concentration is obtained by subtracting the average of the atmospheric concentrations measured by the open path instrument under test immediately before and immediately after the precision check test from the precision test concentration measurement. If the difference between these before and after measurements is greater than 20 percent of the effective concentration of the test gas, discard the test result and repeat the test. If possible, open path analyzers should be tested during periods when the atmospheric pollutant concentrations are relatively low and steady.

3.1.1.3 Report the actual concentration (effective concentration for open path analyzers) of the precision check gas and the corresponding concentration measurement (corrected concentration, if applicable, for open path analyzers) indicated by the analyzer. The percent differences between these concentrations are used to assess the precision of the monitoring data as described in section 5.1. of this Appendix.

3.1.2 Methods for Particulate Matter Excluding $PM_{2.5}$. A one-point precision check must be performed at least once every 2 weeks on each automated analyzer used to measure PM_{10}. The precision check is made by checking the operational flow rate of the analyzer. If a precision flow rate check is made in conjunction with a flow rate adjustment, it must be made prior to such flow rate adjustment. Randomization of the precision check with respect to time of day, day of week, and routine service and adjustments is encouraged where possible.

3.1.2.1 Standard procedure: Use a flow rate transfer standard certified in accordance with section 2.3.3 of this Appendix to check the analyzer's normal flow rate. Care should be used in selecting and using the flow rate measurement device such that it does not alter the normal operating flow rate of the analyzer. Report the actual analyzer flow rate measured by the transfer standard and the corresponding flow rate measured, indicated, or assumed by the analyzer.

3.1.2.2 Alternative procedure:

3.1.2.2.1 It is permissible to obtain the precision check flow rate data from the analyzer's internal flow meter without the use of an external flow rate transfer standard, provided that:

3.1.2.2.1.1 The flow meter is audited with an external flow rate transfer standard at least every 6 months.

3.1.2.2.1.2 Records of at least the three most recent flow audits of the instrument's internal flow meter over at least several weeks confirm that the flow meter is stable, verifiable and accurate to ±4%.

3.1.2.2.1.3 The instrument and flow meter give no indication of improper operation.

3.1.2.2.2 With suitable communication capability, the precision check may thus be carried out remotely. For this procedure, report the set-point flow rate as the actual flow rate along with the flow rate measured or indicated by the analyzer flow meter.

3.1.2.2.3 For either procedure, the percent differences between the actual and indicated flow rates are used to assess the precision of the monitoring data as described in section 5.1 of this Appendix (using flow rates in lieu of concentrations). The percent differences between these concentrations are used to assess the precision of the monitoring data as described in section 5.1. of this Appendix.

3.2 Accuracy of Automated Methods Excluding $PM_{2.5}$.

3.2.1 Methods for SO_2, NO_2, O_3, or CO.

3.2.1.1 Each calendar quarter (during which analyzers are operated), audit at least 25 percent of the SLAMS analyzers that monitor for SO_2, NO_2, O_3, or CO such that each analyzer is audited at least once per year. If there are fewer than four analyzers for a pollutant within a reporting organization, randomly reaudit one or more analyzers so that at least one analyzer for that pollutant is audited each calendar quarter. Where possible, EPA strongly encourages more frequent auditing, up to an audit frequency of once per quarter for each SLAMS analyzer.

3.2.1.2 (a) The audit is made by challenging the analyzer with at least one audit gas of known concentration (effective concentration for open path analyzers) from each of the following ranges applicable to the analyzer being audited:

Audit Level	Concentration Range, PPM		
	SO_2, O_3	NO_2	CO
1	0.03–0.08	0.03–0.08	3–8
2	0.15–0.20	0.15–0.20	15–20
3	0.35–0.45	0.35–0.45	35–45
4	0.80–0.90	....	80–90

(b) NO_2 audit gas for chemiluminescence-type NO_2 analyzers must also contain at least 0.08 ppm NO.

3.2.1.3 NO concentrations substantially higher than 0.08 ppm, as may occur when using some gas phase titration (GPT) techniques, may lead to audit errors in chemiluminescence analyzers due to inevitable minor NO-NO_x channel imbalance. Such errors may be atypical of routine monitoring errors to the extent that such NO concentrations exceed typical ambient NO concentrations at the site. These errors may be minimized by modifying the GPT technique to lower the NO concentrations remaining in the NO_2 audit gas to levels closer to typical ambient NO concentrations at the site.

3.2.1.4 To audit SLAMS analyzers operating on ranges higher than 0 to 1.0 ppm for SO_2, NO_2, and O_3 or 0 to 100 ppm for CO, use audit gases of appropriately higher concentration as approved by the appropriate Regional Administrator or the Administrators's designee. The results of audits at concentration levels other than those shown in the above table need not be reported to EPA.

3.2.1.5 The standards from which audit gas test concentrations are obtained must meet the specifications of section 2.3 of this Appendix. The gas standards and equipment used for auditing must not be the same as the standards and equipment used for calibration or calibration span adjustments. The auditor should not be the operator or analyst who conducts the routine monitoring, calibration, and analysis.

3.2.1.6 For point analyzers, the audit shall be carried out by allowing the analyzer to analyze the audit test atmosphere in its normal sampling mode such that the test atmosphere passes through all filters, scrubbers, conditioners, and other sample inlet components used during normal ambient sampling and as much of the ambient air inlet system as is practicable. The exception provided in section 3.1 of this Appendix for certain CO analyzers does not apply for audits.

3.2.1.7 Open path analyzers are audited by inserting a test cell containing the various audit gas concentrations into the optical measurement beam of the instrument. If possible, the normally used transmitter, receiver, and, as appropriate, reflecting devices should be used during the audit, and the normal monitoring configuration of the instrument should be modified as little as possible to accommodate the test cell for the audit. However, if permitted by the associated operation or instruction manual, an alternate local light source or an alternate optical path that does not include the normal atmospheric monitoring path may be used. The actual concentrations of the audit gas in the test cell must be selected to produce effective concentrations in the ranges specified in this section 3.2 of this Appendix. Generally, each audit concentration measurement result will be the sum of the atmospheric pollutant concentration and the audit test concentration. If so, the result must be corrected to remove the atmospheric concentration contribution. The corrected concentration is obtained by subtracting the average of the atmospheric concentrations measured by the open path instrument under test immediately before and immediately after the audit test (or preferably before and after each audit concentration level) from the audit concentration measurement. If the difference between the before and after measurements is greater than 20 percent of the effective concentration of the test gas standard, discard the test result for that concentration level and repeat the test for that level. If possible, open path analyzers should be audited during periods when the atmospheric pollutant concentrations are relatively low and steady. Also, the monitoring path length must be reverified to within ±3 percent to validate the audit, since the monitoring path length is critical to the determination of the effective concentration.

3.2.1.8 Report both the actual concentrations (effective concentrations for open path analyzers) of the audit gases and the corresponding concentration measurements (corrected concentrations, if applicable, for open path analyzers) indicated or produced by the analyzer being tested. The percent differences between these concentrations are used to assess the accuracy of the monitoring data as described in section 5.2 of this Appendix.

3.2.2 Methods for Particulate Matter Excluding $PM_{2.5}$.

3.2.2.1 Each calendar quarter, audit the flow rate of at least 25 percent of the SLAMS PM_{10} analyzers such that each PM_{10} analyzer is audited at least once per year. If there are fewer than four PM_{10} analyzers within a reporting organization, randomly re-audit one or more analyzers so that at least one analyzer is audited each calendar quarter. Where possible, EPA strongly encourages more frequent auditing, up to an audit frequency of once per quarter for each SLAMS analyzer.

3.2.2.2 The audit is made by measuring the analyzer's normal operating flow rate, using a flow rate transfer standard certified in accordance with section 2.3.3 of this Appendix. The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the analyzer. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate or volume standard. Great care must be used in auditing the flow rate to be certain that the flow measurement device does not alter the normal operating flow rate of the analyzer. Report the audit (actual) flow rate and the corresponding flow rate indicated or assumed by the sampler. The percent differences between these flow rates are used to calculate accuracy (PM_{10}) as described in section 5.2 of this Appendix.

3.3 Precision of Manual Methods Excluding $PM_{2.5}$.

3.3.1 For each network of manual methods other than for $PM_{2.5}$, select one or more monitoring sites within the reporting organization for duplicate, collocated sampling as follows: for 1 to 5 sites, select 1 site; for 6 to 20 sites, select 2 sites; and for over 20 sites, select 3 sites. Where possible, additional collocated sampling is encouraged. For purposes of precision assessment, networks for measuring TSP and PM_{10} shall be considered separately from one another. PM_{10} and TSP sites having annual mean particulate matter concentrations among the highest 25 percent of the annual mean concentrations for all the sites in the network must be selected or, if such sites are impractical, alternative sites approved by the Regional Administrator may be selected.

3.3.2 In determining the number of collocated sites required for PM_{10}, monitoring networks for lead should be treated independently from networks for particulate matter, even though the separate networks may share one or more common samplers. However, a single pair of samplers collocated at a common-sampler monitoring site that meets the requirements for both a collocated lead site and a collocated particulate matter site may serve as a collocated site for both networks.

3.3.3 The two collocated samplers must be within 4 meters of each other, and particulate matter samplers must be at least 2 meters apart to preclude airflow interference. Calibration, sampling, and analysis must be the same for both collocated samplers and the same as for all other samplers in the network.

3.3.4 For each pair of collocated samplers, designate one sampler as the primary sampler whose samples will be used to report air quality for the site, and designate the other as the duplicate sampler. Each duplicate sampler must be operated concurrently with its associated routine sampler at least once per week. The operation schedule should be selected so that the sampling days are distributed evenly over the year and over the seven days of the week. A six-day sampling schedule is required. Report the measurements from both samplers at each collocated sampling site. The calculations for evaluating precision between the two collocated samplers are described in section 5.3 of this Appendix.

3.4 Accuracy of Manual Methods Excluding $PM_{2.5}$. The accuracy of manual sampling methods is assessed by auditing a portion of the measurement process.

3.4.1 Procedures for PM_{10} and TSP.

3.4.1.1 Procedures for flow rate audits for PM_{10}. Each calendar quarter, audit the flow rate of at least 25 percent of the PM_{10} samplers such that each PM_{10} sampler is audited at least once per year. If there are fewer than four PM_{10} samplers within a reporting organization, randomly reaudit one or more samplers so that one sampler is audited each calendar quarter. Audit each sampler at its normal operating flow rate, using a flow rate transfer standard certified in accordance with section 2.3.3 of this Appendix. The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the sampler. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate standard. The flow audit should be scheduled so as to avoid interference with a scheduled sampling period. Report the audit (actual) flow rate and the corresponding flow rate indicated by the sampler's normally used flow indicator. The percent differences between these flow rates are used to calculate accuracy and bias as described in section 5.4.1 of this Appendix.

3.4.1.2 Great care must be used in auditing high-volume particulate matter samplers having flow regulators because the introduction of resistance plates in the audit flow standard device can cause abnormal flow patterns at the point of flow sensing. For this reason, the flow audit standard should be used with a normal filter in place and without resistance plates in auditing flow-regulated high-volume samplers, or other steps should be taken to assure that flow patterns are not perturbed at the point of flow sensing.

3.4.2 SO_2 Methods.

3.4.2.1 Prepare audit solutions from a working sulfite-tetrachloromercurate (TCM) solution as described in section 10.2 of the SO_2 Reference Method (40 CFR part 50, Appendix A). These audit samples must be prepared independently from the standardized sulfite solutions used in the routine calibration procedure. Sulfite-TCM audit samples must be stored between 0 and 5 °C and expire 30 days after preparation.

3.4.2.2 Prepare audit samples in each of the concentration ranges of 0.2-0.3, 0.5-0.6, and 0.8-0.9 μg SO_2/ml. Analyze an audit sample in each of the three ranges at least once each day that samples are analyzed and at least twice per calendar quarter. Report the audit concentrations (in μg SO_2/ml) and the corresponding indicated concentrations (in μg SO_2/ml). The percent differences between these concentrations are used to calculate accuracy as described in section 5.4.2 of this Appendix.

3.4.3 NO_2 Methods. Prepare audit solutions from a working sodium nitrite solution as described in the appropriate equivalent method (see Reference 8 of this Appendix). These audit samples must be prepared independently from the standardized nitrite solutions used in the routine calibration procedure. Sodium nitrite audit samples expire in 3 months after preparation. Prepare audit samples in each of the concentration ranges of 0.2-0.3, 0.5-0.6, and 0.8-0.9 μg NO_2/ml. Analyze an audit sample in each of the three ranges at least once each day that samples are analyzed and at least twice per calendar quarter. Report the audit concentrations (in μg NO_2/ml) and the corresponding indicated concentrations (in μg NO_2/ml). The percent differences between these concentrations are used to calculate accuracy as described in section 5.4.2 of this Appendix.

3.4.4 Pb Methods.

3.4.4.1 For the Pb Reference Method (40 CFR part 50, Appendix G), the flow rates of the high-volume Pb samplers shall be audited as part of the TSP network using the same procedures described in section 3.4.1 of this Appendix. For agencies operating both TSP and Pb networks, 25 percent of the total number of high-volume samplers are to be audited each quarter.

3.4.4.2 Each calendar quarter, audit the Pb Reference Method analytical procedure using glass fiber filter strips containing a known quantity of Pb. These audit sample strips are prepared by depositing a Pb solution on unexposed glass fiber filter strips of dimensions 1.9 cm by 20.3 cm (3/4 inch by 8 inch) and allowing them to dry thoroughly. The audit samples must be prepared using batches of reagents different from those used to calibrate the Pb analytical equipment being audited. Prepare audit samples in the following concentration ranges:

Range	Pb Concentration, μg/Strip	Equivalent Ambient Pb Concentration, μg/m³ [1]
1	100–300	0.5–1.5
2	600–1000	3.0–5.0

[1] Equivalent ambient Pb concentration in μg/m³ is based on sampling at 1.7 m³/min for 24 hours on a 20.3 cm×25.4 cm (8 inch×10 inch) glass fiber filter.

3.4.4.3 Audit samples must be extracted using the same extraction procedure used for exposed filters.

3.4.4.4 Analyze three audit samples in each of the two ranges each quarter samples are analyzed. The audit sample analyses shall be distributed as much as possible over the entire calendar quarter. Report the audit concentrations (in μg Pb/strip) and the corresponding measured concentrations (in μg Pb/strip) using unit code 77. The percent differences between the concentrations are used to calculate analytical accuracy as described in section 5.4.2 of this Appendix.

3.4.4.5 The accuracy of an equivalent Pb method is assessed in the same manner as for the reference method. The flow auditing device and Pb analysis audit samples must be compatible with the specific requirements of the equivalent method.

3.5 Measurement Uncertainty for Automated and Manual $PM_{2.5}$ Methods. The goal for acceptable measurement uncertainty has been defined as 10 percent coefficient of variation (CV) for total precision and ± 10 percent for total bias (Reference 14 of this Appendix).

3.5.1 Flow Rate Audits.

3.5.1.1 Automated methods for $PM_{2.5}$. A one-point precision check must be performed at least once every 2 weeks on each automated analyzer used to measure $PM_{2.5}$. The precision check is made by checking the operational flow rate of the analyzer. If a precision flow rate check is made in conjunction with a flow rate adjustment, it must be made prior to such flow rate adjustment. Randomization of the precision check with respect to time of day, day of week, and routine service and adjustments is encouraged where possible.

3.5.1.1.1 Standard procedure: Use a flow rate transfer standard certified in accordance with section 2.3.3 of this Appendix to check the analyzer's normal flow rate. Care should be used in selecting and using the flow rate measurement device such that it does not alter the normal operating flow rate of the analyzer. Report the actual analyzer flow rate measured by the transfer standard and the corresponding flow rate measured, indicated, or assumed by the analyzer.

3.5.1.1.2 Alternative procedure: It is permissible to obtain the precision check flow rate data from the analyzer's internal flow meter without the use of an external flow rate transfer standard, provided that the flow meter is audited with an external flow rate transfer standard at least every 6 months; records of at least the three most recent flow audits of the instrument's internal flow meter over at least several weeks confirm that the flow meter is stable, verifiable and accurate to ±4%; and the instrument and flow meter give no indication of improper operation. With suitable communication capability, the precision check may thus be carried out remotely. For this procedure, report the set-point flow rate as the actual flow rate along with the flow rate measured or indicated by the analyzer flow meter.

3.5.1.1.3 For either procedure, the differences between the actual and indicated flow rates are used to assess the precision of the monitoring data as described in section 5.5 of this Appendix.

3.5.1.2 Manual methods for $PM_{2.5}$. Each calendar quarter, audit the flow rate of each SLAMS $PM_{2.5}$ analyzer. The audit is made by measuring the analyzer's normal operating flow rate, using a flow rate transfer standard certified in accordance with section 2.3.3 of this Appendix. The flow rate standard used for auditing must not be the same flow rate standard used to calibrate the analyzer. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate or volume standard. Great care must be used in auditing the flow rate to be certain that the flow measurement device does not alter the normal operating flow rate of the analyzer. Report the audit (actual) flow rate and the corresponding flow rate indicated or assumed by the sampler. The procedures used to calculate measurement uncertainty $PM_{2.5}$ are described in section 5.5 of this Appendix.

3.5.2 Measurement of Precision using Collocated Procedures for Automated and Manual Methods of $PM_{2.5}$.

(a) For $PM_{2.5}$ sites within a reporting organization each EPA designated Federal reference method (FRM) or Federal equivalent method (FEM) must:

(1) Have 25 percent of the monitors collocated (values of .5 and greater round up).

(2) Have at least 1 collocated monitor (if the total number of monitors is less than 4). The first collocated monitor must be a designated FRM monitor.

(b) In addition, monitors selected must also meet the following requirements:

(1) A monitor designated as an EPA FRM shall be collocated with a monitor having the same EPA FRM designation.

(2) For each monitor designated as an EPA FEM, 50 percent of the designated monitors shall be collocated with a monitor having the same method designation and 50 percent of the monitors shall be collocated with an FRM monitor. If there are an odd number of collocated monitors required, the additional monitor shall be an FRM. An example of this procedure is found in Table A-2 of this Appendix.

(c) For $PM_{2.5}$ sites during the initial deployment of the SLAMS network, special emphasis should be placed on those sites in areas likely to be in violation of the NAAQS. Once areas are initially determined to be in violation, the collocated monitors should be deployed according to the following protocol:

(1) Eighty percent of the collocated monitors should be deployed at sites with concentrations ≥ ninety percent of the annual $PM_{2.5}$ NAAQS (or 24–hour NAAQS if that is affecting the area); one hundred percent if all sites have concentrations above either NAAQS, and each area determined to be in violation should be represented by at least one collocated monitor.

(2) The remaining 20 percent of the collocated monitors should be deployed at sites with concentrations < ninety percent of the annual $PM_{2.5}$ NAAQS (or 24–hour NAAQS if that is affecting the area)

(3) If an organization has no sites at concentration ranges ≥ ninety percent of the annual $PM_{2.5}$ NAAQS (or 24–hour NAAQS if that is affecting the area), 60 percent of the collocated monitors should be deployed at those sites with the annual mean $PM_{2.5}$ concentrations (or 24–hour NAAQS if that is affecting the area) among the highest 25 percent for all $PM_{2.5}$ sites in the network.

3.5.2.1 In determining the number of collocated sites required for $PM_{2.5}$, monitoring networks for visibility should not be treated independently from networks for particulate matter, as the separate networks may share one or more common samplers. However, for class I visibility areas, EPA will accept visibility aerosol mass measurement instead of a $PM_{2.5}$ measurement if the latter measurement is unavailable. Any $PM_{2.5}$ monitoring site which does not have a monitor which is an EPA federal reference or equivalent method is not required to be included in the number of sites which are used to determine the number of collocated monitors.

3.5.2.2 The two collocated samplers must be within 4 meters of each other, and particulate matter samplers must be at least 2 meters apart to preclude airflow interference. Calibration, sampling, and analysis must be the same for both collocated samplers and the same as for all other samplers in the network.

3.5.2.3 For each pair of collocated samplers, designate one sampler as the primary sampler whose samples will be used to report air quality for the site, and designate the other as the duplicate sampler. Each duplicate sampler must be operated concurrently with its associated primary sampler. The operation schedule should be selected so that the sampling days are distributed evenly over the year and over the 7 days of the week and therefore, a 6-day sampling schedule is required. Report the measurements from both samplers at each collocated sampling site. The calculations for evaluating precision between the two collocated samplers are described in section 5.5 of this Appendix.

3.5.3 Measurement of Bias using the FRM Audit Procedures for Automated and Manual Methods of $PM_{2.5}$.

3.5.3.1 The FRM audit is an independent assessment of the total measurement system bias. These audits will be performed under the National Performance Audit Program (section 2.4 of this Appendix) or a comparable program. Twenty-five percent of the SLAMS monitors within each reporting organization will be assessed with an FRM audit each year. Additionally, every designated FRM or FEM within a reporting organization must:

(a) Have at least 25 percent of each method designation audited, including collocated sites (even those collocated with FRM instruments), (values of .5 and greater round up).

(b) Have at least one monitor audited.

(c) Be audited at a frequency of four audits per year.

(d) Have all FRM or FEM samples subject to an FRM audit at least once every 4 years. Table A-2 illustrates the procedure mentioned above.

3.5.3.2 For $PM_{2.5}$ sites during the initial deployment of the SLAMS network, special emphasis should be placed on those sites in areas likely to be in violation of the NAAQS. Once areas are initially determined to be in violation, the FRM audit program should be implemented according to the following protocol:

(a) Eighty percent of the FRM audits should be deployed at sites with concentrations ≥ ninety percent of the annual $PM_{2.5}$ NAAQS (or 24–hour NAAQS if that is affecting the area); one hundred percent if all sites have concentrations above either NAAQS, and each area determined to be in violation should implement an FRM audit at a minimum of one monitor within that area.

(b) The remaining 20 percent of the FRM audits should be implemented at sites with concentrations < ninety percent of the annual $PM_{2.5}$ NAAQS (or 24–hour NAAQS if that is affecting the area).

(c) If an organization has no sites at concentration ranges ≥ ninety percent of the annual $PM_{2.5}$ NAAQS (or 24–hour NAAQS if that is affecting the area), 60 percent of the FRM audits should be implemented at those sites with the annual mean $PM_{2.5}$ concentrations (or 24–hour NAAQS if that is affecting the area) among the highest 25 percent for all $PM_{2.5}$ sites in the network. Additional information concerning the FRM audit program is contained in Reference 7 of this Appendix. The calculations for evaluating bias between the primary monitor and the FRM audit are described in section 5.5.

4. *Reporting Requirements*.

(a) For each pollutant, prepare a list of all monitoring sites and their AIRS site identification codes in each reporting organization and submit the list to the appropriate EPA Regional Office, with a copy to AIRS-AQS. Whenever there is a change in this list of monitoring sites in a reporting organization, report this change to the Regional Office and to AIRS-AQS.

4.1 Quarterly Reports. For each quarter, each reporting organization shall report to AIRS-AQS directly (or via the appropriate EPA Regional Office for organizations not direct users of AIRS) the results of all valid precision, bias and accuracy tests it has carried out during the quarter. The quarterly reports of precision, bias and accuracy data must be submitted consistent with the data reporting requirements specified for air quality data as set forth in § 58.35(c). EPA strongly encourages early submittal of the QA data in order to assist the State and Local agencies in controlling and evaluating the quality of the ambient air SLAMS data. Each organization shall report all QA/QC measurements. Report results from invalid tests, from tests carried out during a time period for which ambient data immediately prior or subsequent to the tests were invalidated for appropriate reasons, and from tests of methods or analyzers not approved for use in SLAMS monitoring networks under Appendix C of this part. Such data should be flagged so that it will not be utilized for quantitative assessment of precision, bias and accuracy.

4.2 Annual Reports.

4.2.1 When precision, bias and accuracy estimates for a reporting organization have been calculated for all four quarters of the calendar year, EPA will calculate and report the measurement uncertainty for the entire calendar year. These limits will then be associated with the data submitted in the annual SLAMS report required by § 58.26.

4.2.2 Each reporting organization shall submit, along with its annual SLAMS report, a listing by pollutant of all monitoring sites in the reporting organization.

5. *Calculations for Data Quality Assessment*.

(a) Calculations of measurement uncertainty are carried out by EPA according to the following procedures. Reporting organizations should report the data for individual precision, bias and accuracy tests as specified in sections 3 and 4 of this Appendix even though they may elect to perform some or all of the calculations in this section on their own.

5.1 Precision of Automated Methods Excluding $PM_{2.5}$. Estimates of the precision of automated methods are calculated from the results of biweekly precision checks as specified in section 3.1 of this Appendix. At the end of each calendar quarter, an integrated precision probability interval for all SLAMS analyzers in the organization is calculated for each pollutant.

5.1.1 Single Analyzer Precision.

5.1.1.1 The percent difference (d_i) for each precision check is calculated using equation 1, where Y_i is the concentration indicated by the analyzer for the I-th precision check and X_i is the known concentration for the I-th precision check, as follows:

Equation 1

$$d_i = \frac{Y_i - X_i}{X_i} \times 100$$

5.1.1.2 For each analyzer, the quarterly average (d_j) is calculated with equation 2, and the standard deviation (S_j) with equation 3, where n is the number of precision checks on the instrument made during the calendar quarter. For example, n should be 6 or 7 if precision checks are made biweekly during a quarter. Equation 2 and 3 follow:

Equation 2

$$d_j = \frac{1}{n} \sum_{i=1}^{n} d_i$$

Equation 3

$$S_j = \sqrt{\frac{1}{n-1}\left[\sum_{i=1}^{n} d_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} d_i\right)^2\right]}$$

5.1.2 Precision for Reporting Organization.

5.1.2.1 For each pollutant, the average of averages (D) and the pooled standard deviation (S_a) are calculated for all analyzers audited for the pollutant during the quarter, using either equations 4 and 5 or 4a and 5a, where k is the number of analyzers audited within the reporting organization for a single pollutant, as follows:

Equation 4

$$D = \frac{1}{k} \sum_{j=1}^{k} d_j$$

Equation 4a

$$D = \frac{n_1 d_1 + n_2 d_2 + \ldots + n_j d_j + \ldots + n_k d_k}{n_1 + n_2 + \ldots + n_j + \ldots + n_k}$$

Equation 5

$$S_a = \sqrt{\frac{1}{k}\sum_{j=1}^{k} S_j^2}$$

Equation 5a

$$S_a = \sqrt{\frac{(n_1-1)S_1^2 + (n_2-1)S_2^2 + \ldots + (n_j-1)S_j^2 + \ldots + (n_k-1)S_k^2}{n_1 + n_2 + \ldots + n_j + \ldots + n_k - k}}$$

5.1.2.2 Equations 4 and 5 are used when the same number of precision checks are made for each analyzer. Equations 4a and 5a are used to obtain a weighted average and a weighted standard deviation when different numbers of precision checks are made for the analyzers.

5.1.2.3 For each pollutant, the 95 Percent Probability Limits for the precision of a reporting organization are calculated using equations 6 and 7, as follows:

Equation 6

$$\text{Upper 95 Percent Probability Limit} = D + 1.96\ S_a$$

Equation 7

$$\text{Lower 95 Percent Probability Limit} = D - 1.96\ S_a$$

5.2 Accuracy of Automated Methods Excluding $PM_{2.5}$. Estimates of the accuracy of automated methods are calculated from the results of independent audits as described in section 3.2 of this Appendix. At the end of each calendar quarter, an integrated accuracy probability interval for all SLAMS analyzers audited in the reporting organization is calculated for each pollutant. Separate probability limits are calculated for each audit concentration level in section 3.2 of this Appendix.

5.2.1 Single Analyzer Accuracy. The percentage difference (d_i) for each audit concentration is calculated using equation 1, where Y_i is the analyzer's indicated concentration measurement from the I-th audit check and X_i is the actual concentration of the audit gas used for the I-th audit check.

5.2.2 Accuracy for Reporting Organization.

5.2.2.1 For each audit concentration level of a particular pollutant, the average (D) of the individual percentage differences (d_i) for all n analyzers audited during the quarter is calculated using equation 8, as follows:

Equation 8

$$D = \frac{1}{n} \sum_{i=1}^{n} d_i$$

5.2.2.2 For each concentration level of a particular pollutant, the standard deviation (S_a) of all the individual percentage differences for all n analyzers audited during the quarter is calculated, using equation 9, as follows:

Equation 9

$$S_a = \sqrt{\frac{1}{n-1}\left[\sum_{i=1}^{n} d_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} d_i\right)^2\right]}$$

5.2.2.3 For reporting organizations having four or fewer analyzers for a particular pollutant, only one audit is required each quarter. For such reporting organizations, the audit results of two consecutive quarters are required to calculate an average and a standard deviation, using equations 8 and 9. Therefore, the reporting of probability limits shall be on a semiannual (instead of a quarterly) basis.

5.2.2.4 For each pollutant, the 95 Percent Probability Limits for the accuracy of a reporting organization are calculated at each audit concentration level using equations 6 and 7.

5.3 Precision of Manual Methods Excluding $PM_{2.5}$. Estimates of precision of manual methods are calculated from the results obtained from collocated samplers as described in section 3.3 of this Appendix. At the end of each calendar quarter, an integrated precision probability interval for all collocated samplers operating in the reporting organization is calculated for each manual method network.

5.3.1 Single Sampler Precision.

5.3.1.1 At low concentrations, agreement between the measurements of collocated samplers, expressed as percent differences, may be relatively poor. For this reason, collocated measurement pairs are selected for use in the precision calculations only when both measurements are above the following limits:

(a) TSP: 20 µg/m³.

(b) SO_2: 45 µg/m³.

(c) NO_2: 30 µg/m³.

(d) Pb: 0.15 µg/m³.

(e) PM_{10}: 20 µg/m³.

5.3.1.2 For each selected measurement pair, the percent difference (d_i) is calculated, using equation 10, as follows:

Equation 10

$$d_i = \frac{Y_i - X_i}{(Y_i + X_i)/2} \times 100$$

where:

Y_i is the pollutant concentration measurement obtained from the duplicate sampler; and

X_i is the concentration measurement obtained from the primary sampler designated for reporting air quality for the site.

(a) For each site, the quarterly average percent difference (d_j) is calculated from equation 2 and the standard deviation (S_j) is calculated from equation 3, where n= the number of selected measurement pairs at the site.

5.3.2 Precision for Reporting Organization.

5.3.2.1 For each pollutant, the average percentage difference (D) and the pooled standard deviation (S_a) are calculated, using equations 4 and 5, or using equations 4a and 5a if different numbers of paired measurements are obtained at the collocated sites. For these calculations, the k of equations 4, 4a, 5 and 5a is the number of collocated sites.

5.3.2.2 The 95 Percent Probability Limits for the integrated precision for a reporting organization are calculated using equations 11 and 12, as follows:

Equation 11

$$\text{Upper 95 Percent Probability Limit} = D + 1.96\ S_a$$

Equation 12

$$\text{Lower 95 Percent Probability Limit} = D - 1.96\ S_a$$

5.4 Accuracy of Manual Methods Excluding $PM_{2.5}$. Estimates of the accuracy of manual methods are calculated from the results of independent audits as described in section 3.4 of this Appendix. At the end of each calendar quarter, an integrated accuracy probability interval is calculated for each manual method network operated by the reporting organization.

5.4.1 Particulate Matter Samplers other than $PM_{2.5}$ (including reference method Pb samplers).

5.4.1.1 Single Sampler Accuracy. For the flow rate audit described in section 3.4.1 of this Appendix, the percentage difference (d_i) for each audit is calculated using equation 1, where X_i represents the known flow rate and Y_i represents the flow rate indicated by the sampler.

5.4.1.2 Accuracy for Reporting Organization. For each type of particulate matter measured (e.g., TSP/Pb), the average (D) of the individual percent differences for all similar particulate matter samplers audited during the calendar quarter is calculated using equation 8. The standard deviation (S_a) of the percentage differences for all of the similar particulate matter samplers audited during the calendar quarter is calculated using equation 9. The 95 Percent Probability Limits for the integrated accuracy for the reporting organization are calculated using equations 6 and 7. For reporting organizations having four or fewer particulate matter samplers of one type, only one audit is required each quarter, and the audit results of two consecutive quarters are required to calculate an average and a standard deviation. In that case, probability limits shall be reported semi-annually rather than quarterly.

5.4.2 Analytical Methods for SO_2, NO_2, and Pb.

5.4.2.1 Single Analysis-Day Accuracy. For each of the audits of the analytical methods for SO_2, NO_2, and Pb described in sections 3.4.2, 3.4.3, and 3.4.4 of this Appendix, the percentage difference (d_j) at each concentration level is calculated using equation 1, where X_j represents the known value of the audit sample and Y_j represents the value of SO_2, NO_2, or Pb indicated by the analytical method.

5.4.2.2 Accuracy for Reporting Organization. For each analytical method, the average (D) of the individual percent differences at each concentration level for all audits during the calendar quarter is calculated using equation 8. The standard deviation (S_a) of the percentage differences at each concentration level for all audits during the calendar quarter is calculated using equation 9. The 95 Percent Probability Limits for the accuracy for the reporting organization are calculated using equations 6 and 7.

5.5 Precision, Accuracy and Bias for Automated and Manual $PM_{2.5}$ Methods.

(a) Reporting organizations are required to report the data that will allow assessments of the following individual quality control checks and audits:

(1) Flow rate audit.

(2) Collocated samplers, where the duplicate sampler is not an FRM device.

(3) Collocated samplers, where the duplicate sampler is an FRM device.

(4) FRM audits.

(b) EPA uses the reported results to derive precision, accuracy and bias estimates according to the following procedures.

5.5.1 Flow Rate Audits. The reporting organization shall report both the audit standard flow rate and the flow rate indicated by the sampling instrument. These results are used by EPA to calculate flow rate accuracy and bias estimates.

5.5.1.1 Accuracy of a Single Sampler - Single Check (Quarterly) Basis (d_i). The percentage difference (d_i) for a single flow rate audit d_i is calculated using Equation 13, where X_i represents the audit standard flow rate (known) and Y_i represents the indicated flow rate, as follows:

Equation 13

$$d_i = \frac{Y_i - X_i}{X_i} \times 100$$

5.5.1.2 Bias of a Single Sampler - Annual Basis (D_j). For an individual particulate sampler j, the average (D_j) of the individual percentage differences (d_i) during the calendar year is calculated using Equation 14, where n_j is the number of individual percentage differences produced for sampler j during the calendar year, as follows:

Equation 14

$$D_j = \frac{1}{n_j} \times \sum_{i=1}^{n_j} d_i$$

5.5.1.3 Bias for Each EPA Federal Reference and Equivalent Method Designation Employed by Each Reporting Organization - Quarterly Basis ($D_{k,q}$). For method designation k used by the reporting organization, quarter q's single sampler percentage differences (d_i) are averaged using Equation 16, where $n_{k,q}$ is the number of individual percentage differences produced for method designation k in quarter q, as follows:

Equation 15

$$D_{k,q} = \frac{1}{n_{k,q}} \times \sum_{i=1}^{n_{k,q}} d_i$$

5.5.1.4 Bias for Each Reporting Organization - Quarterly Basis (D_q). For each reporting organization, quarter q's single sampler percentage differences (d_i) are averaged using Equation 16, to produce a single average for each reporting organization, where n_q is the total number of single sampler percentage differences for all federal reference or equivalent methods of samplers in quarter q, as follows:

Equation 16

$$D_q = \frac{1}{n_q} \times \sum_{i=1}^{n_q} d_i$$

5.5.1.5 Bias for Each EPA Federal Reference and Equivalent Method Designation Employed by Each Reporting Organization - Annual Basis (D_k). For method designation k used by the reporting organization, the annual average percentage difference, D_k, is derived using Equation 17, where $D_{k,q}$ is the average reported for method designation k during the qth quarter, and $n_{k,q}$ is the number of the method designation k's monitors that were deployed during the qth quarter, as follows:

Equation 17

$$D_k = \frac{\sum_{q=1}^{4} \left(n_{k,q} D_{k,q}\right)}{\sum_{q=1}^{4} n_{k,q}}$$

5.5.1.6 Bias for Each Reporting Organization - Annual Basis (D). For each reporting organization, the annual average percentage difference, D, is derived using Equation 18, where D_q is the average reported for the reporting organization during the qth quarter, and n_q is the total number monitors that were deployed during the qth quarter. A single annual average is produced for each reporting organization. Equation 18 follows:

Equation 18

$$D = \frac{\sum_{q=1}^{4} \left(n_q D_q\right)}{\sum_{q=1}^{4} n_q}$$

5.5.2 Collocated Samplers, Where the Duplicate Sampler is not an FRM Device.

(a) At low concentrations, agreement between the measurements of collocated samplers may be relatively poor. For this reason, collocated measurement pairs are selected for use in the precision calculations only when both measurements are above the following limits:

$PM_{2.5}$: 6 µg/m^3

(b) Collocated sampler results are used to assess measurement system precision. A collocated sampler pair consists of a primary sampler (used for routine monitoring) and a duplicate sampler (used as a quality control check). Quarterly precision estimates are calculated by EPA for each pair of collocated samplers and for each method designation employed by each reporting organization. Annual precision estimates are calculated by EPA for each primary sampler, for each EPA Federal reference method and equivalent method designation employed by each reporting organization, and nationally for each EPA Federal reference method and equivalent method designation.

5.5.2.1 Percent Difference for a Single Check (d_i). The percentage difference, d_i, for each check is calculated by EPA using Equation 19, where X_i represents the concentration produced from the primary sampler and Y_i represents concentration reported for the duplicate sampler, as follows:

Equation 19

$$d_i = \frac{Y_i - X_i}{\left(Y_i + X_i\right)/2} \times 100$$

5.5.2.2 Coefficient of Variation (CV) for a Single Check (CV_i). The coefficient of variation, CV_i, for each check is calculated by EPA by dividing the absolute value of the percentage difference, d_i, by the square root of two as shown in Equation 20, as follows:

Equation 20

$$CV_i = \frac{|d_i|}{\sqrt{2}}$$

5.5.2.3 Precision of a Single Sampler - Quarterly Basis ($CV_{j,q}$).

(a) For particulate sampler j, the individual coefficients of variation ($CV_{j,q}$) during the quarter are pooled using Equation 21, where $n_{j,q}$ is the number of pairs of measurements from collocated samplers during the quarter, as follows:

Equation 21

$$CV_{j,q} = \sqrt{\frac{\sum_{i=1}^{n_j} CV_i^2}{n_{j,q}}}$$

(b) The 90 percent confidence limits for the single sampler's CV are calculated by EPA using Equations 22 and 23, where $X^2_{0.05,df}$ and $X^2_{0.95,df}$ are the 0.05 and 0.95 quantiles of the chi-square (X^2) distribution with $n_{j,q}$ degrees of freedom, as follows:

Equation 22

$$\text{Lower Confidence Limit} = CV_{j,q}\sqrt{\frac{n_{j,q}}{\chi^2_{0.95,\ n_{j,q}}}}$$

Equation 23

$$\text{Upper Confidence Limit} = CV_{j,q}\sqrt{\frac{n_{j,q}}{\chi^2_{0.05,\ n_{j,q}}}}$$

5.5.2.4 Precision of a Single Sampler - Annual Basis. For particulate sampler j, the individual coefficients of variation, CV_i, produced during the calendar year are pooled using Equation 21, where n_j is the number of checks made during the calendar year. The 90 percent confidence limits for the single sampler's CV are calculated by EPA using Equations 22 and 23, where $X^2_{0.05,df}$ and $X^2_{0.95,df}$ are the 0.05 and 0.95 quantiles of the chi-square (X^2) distribution with n_j degrees of freedom.

5.5.2.5 Precision for Each EPA Federal Reference Method and Equivalent Method Designation Employed by Each Reporting Organization - Quarterly Basis ($CV_{k,q}$).

(a) For each method designation k used by the reporting organization, the quarter's single sampler coefficients of variation, $CV_{j,q}$s, obtained from Equation 21, are pooled using Equation 24, where $n_{k,q}$ is the number of collocated primary monitors for the designated method (but not collocated with FRM samplers) and $n_{j,q}$ is the number of degrees of freedom associated with $CV_{j,q}$, as follows:

Equation 24

$$CV_{k,q} = \sqrt{\frac{\sum_{j=1}^{n_{k,q}} \left(CV_{j,q}^2 n_{j,q}\right)}{\sum_{j=1}^{n_{k,q}} n_{j,q}}}$$

(b) The number of method CVs produced for a reporting organization will equal the number of different method designations having more than one primary monitor employed by the organization during the quarter. (When exactly one monitor of a specified designation is used by a reporting organization, it will be collocated with an FRM sampler.)

5.5.2.6 Precision for Each Method Designation Employed by Each Reporting Organization- Annual Basis (CV_k). For each method designation k used by the reporting organization, the quarterly estimated coefficients of variation, $CV_{k,q}$, are pooled using Equation 25, where $n_{k,q}$ is the number of collocated primary monitors for the designated method during the qth quarter and also the number of degrees of freedom associated with the quarter's precision estimate for the method designation, $CV_{k,q}$, as follows:

Equation 25

$$CV_k = \sqrt{\frac{\sum_{q=1}^{4} \left(CV_{k,q}^2 n_{k,q}\right)}{\sum_{q=1}^{4} n_{k,q}}}$$

5.5.3 Collocated Samplers, Where the Duplicate Sampler is an FRM Device. At low concentrations, agreement between the measurements of collocated samplers may be relatively poor. For this reason, collocated measurement pairs are selected for use in the precision calculations only when both measurements are above the following limits: $PM_{2.5}$: 6 μg/m^3. These duplicate sampler results are used to assess measurement system bias. Quarterly bias estimates are calculated by EPA for each primary sampler and for each method designation employed by each reporting organization. Annual precision estimates are calculated by EPA for each primary monitor, for each method designation employed by each reporting organization, and nationally for each method designation.

5.5.3.1 Accuracy for a Single Check (d'_i). The percentage difference, d'_i, for each check is calculated by EPA using Equation 26, where X_i represents the concentration produced from the FRM sampler taken as the true value and Y_i represents concentration reported for the primary sampler, as follows:

Equation 26

$$d_i^{'} = \frac{Y_i - X_i}{X_i} \times 100\%$$

5.5.3.2 Bias of a Single Sampler - Quarterly Basis ($D'_{j,q}$).

(a) For particulate sampler j, the average of the individual percentage differences during the quarter q is calculated by EPA using Equation 27, where $n_{j,q}$ is the number of checks made for sampler j during the calendar quarter, as follows:

Equation 27

$$D_{j,q}^{'} = \frac{1}{n_{j,q}} \times \sum_{i=1}^{n_{j,q}} d^{'}_i$$

(b) The standard deviation, $s'_{j,q}$, of sampler j's percentage differences for quarter q is calculated using Equation 28, as follows:

Equation 28

$$s_{j,q}^{'} = \sqrt{\frac{1}{n_{j,q}-1} \times \left[\left(\sum_{i=1}^{n_{j,q}} d_i^{'2}\right) - \left(n_{j,q} D_{j,q}^{'2}\right)\right]}$$

(c) The 95 Percent Confidence Limits for the single sampler's bias are calculated using Equations 29 and 30 where $t_{0.975,df}$ is the 0.975 quantile of Student's t distribution with df = $n_{j,q}$-1 degrees of freedom, as follows:

Equation 29

$$\text{Lower Confidence Limit} = D_{j,q}^{'} - t_{0.975,df} \times s_{j,q}^{'}$$

Equation 30

$$\text{Upper Confidence Limit} = D_{j,q}^{'} - t_{0.975,df} \times s_{j,q}^{'}$$

5.5.3.3 Bias of a Single Sampler - Annual Basis (D'_j).

(a) For particulate sampler j, the mean bias for the year is derived from the quarterly bias estimates, $D'_{j,q}$, using Equation 31, where the variables are as defined for Equations 27 and 28, as follows:

Equation 31

$$D_j^{'} = \frac{\sum_{q=1}^{4} \left(n_{j,q} D_{j,q}^{'}\right)}{\sum_{q=1}^{4} n_{j,q}}$$

(b) The standard error of the above estimate, se_j' is calculated using Equation 32, as follows:

Equation 32

$$se'_j = \sqrt{\frac{\sum_{q=1}^{4}\left[s'_{j,q}\ 2 \times \left(n_{j,q}-1\right)\right]}{\sum_{q=1}^{4}\left(n_{j,q}-1\right)\sum_{q=1}^{4}\left(n_{j,q}\right)}}$$

(c) The 95 Percent Confidence Limits for the single sampler's bias are calculated using Equations 33 and 34, where $t_{0.975,df}$ is the 0.975 quantile of Student's t distribution with $df=(n_{j,1}+n_{j,2}+n_{j,3}+n_{j,4}-4)$ degrees of freedom, as follows:

Equation 33

$$\text{Lower Confidence Limit} = D'_j - t_{0.975,df} \times se'_j$$

Equation 34

$$\text{Upper Confidence Limit} = D'_j - t_{0.975,df} \times se'_j$$

5.5.3.4 Bias for a Single Reporting Organization (D') - Annual Basis. The reporting organizations mean bias is calculated using Equation 35, where variables are as defined in Equations 31 and 32, as follows:

Equation 35

$$D' = \frac{1}{n_j} \times \sum_{i=1}^{n_j} D'_j$$

5.5.4 FRM Audits. FRM Audits are performed once per quarter for selected samplers. The reporting organization reports concentration data from the primary sampler. Calculations for FRM Audits are similar to those for collocated samplers having FRM samplers as duplicates. The calculations differ because only one check is performed per quarter.

5.5.4.1 Accuracy for a Single Sampler, Quarterly Basis (d_i). The percentage difference, d_i, for each check is calculated using Equation 26, where X_i represents the concentration produced from the FRM sampler and Y_i represents the concentration reported for the primary sampler. For quarter q, the bias estimate for sampler j is denoted $D_{j,q}$.

5.5.4.2 Bias of a Single Sampler - Annual Basis (D'_j). For particulate sampler j, the mean bias for the year is derived from the quarterly bias estimates, $D_{j,q}$, using Equation 31, where $n_{j,q}$ equals 1 because one FRM audit is performed per quarter.

5.5.4.3. Bias for a Single Reporting Organization - Annual Basis (D'). The reporting organizations mean bias is calculated using Equation 35, where variables are as defined in Equations 31 and 32.

References in Appendix A of Part 58

(1) Rhodes, R.C. Guideline on the Meaning and Use of Precision and Accuracy Data Required by 40 CFR part 58, Appendices A and B. EPA-600/4-83/023. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, June, 1983.

(2) American National Standard--Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs. ANSI/ASQC E4-1994. January 1995. Available from American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202.

(3) EPA Requirements for Quality Management Plans. EPA QA/R-2. August 1994. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(4) EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. EPA QA/R-5. August 1994. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(5) Guidance for the Data Quality Objectives Process. EPA QA/G-4. September 1994. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(6) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 1--A Field Guide to Environmental Quality Assurance. EPA-600/R-94/038a. April 1994. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(7) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II--Ambient Air Specific Methods EPA-600/R-94/038b. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(7a) Copies of section 2.12 of the Quality Assurance Handbook for Air Pollution Measurement Systems, are available from Department E (MD-77B), U.S. EPA, Research Triangle Park, NC 27711.

(8) List of Designated Reference and Equivalent Methods. Available from U.S. Environmental Protection Agency, National Exposure Research Laboratory, Quality Assurance Branch, MD-77B, Research Triangle Park, NC 27711.

(9) Technical Assistance Document for Sampling and Analysis of Ozone Precursors. Atmospheric Research and Exposure Assessment Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. EPA 600/8-91-215. October 1991.

(10) EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards. EPA-600/R-93/224. September 1993. Available from U.S. Environmental Protection Agency, ORD Publications Office, Center for Environmental Research Information (CERI), 26 W. Martin Luther King Drive, Cincinnati, OH 45268.

(11) Paur, R.J. and F.F. McElroy. Technical Assistance Document for the Calibration of Ambient Ozone Monitors. EPA-600/4-79-057. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, September, 1979.

(12) McElroy, F.F. Transfer Standards for the Calibration of Ambient Air Monitoring Analyzers for Ozone. EPA-600/4-79-056. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, September, 1979.

(13) Musick, D.R. The Ambient Air Precision and Accuracy Program: 1995 Annual Report. EPA-454/R97001. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, February 1997.

(14) Papp, M.L., J,B., Elkins, D.R., Musick and M.J., Messner, Data Quality Objectives for the $PM_{2.5}$. Monitoring Data, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. In preparation.

(15) Photochemical Assessment Monitoring Stations Implementation Manual. EPA-454/B-93-051, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, March 1994.

Tables to Appendix A of Part 58

TABLE A–1.—MINIMUM DATA ASSESSMENT REQUIREMENTS

Method	Assessment Method	Coverage	Minimum Frequency	Parameters Reported
Precision:				

TABLE A–1.—MINIMUM DATA ASSESSMENT REQUIREMENTS—Continued

Method	Assessment Method	Coverage	Minimum Frequency	Parameters Reported
Automated Methods for SO_2, NO_2, O_3, and CO	Response check at concentration between .08 and .10 ppm (8 & 10 ppm for CO) [2]	Each analyzer	Once per 2 weeks	Actual concentration [2] and measured concentration [3]
Manual Methods: All methods except $PM_{2.5}$	Collocated samplers	1 site for 1–5 sites 2 sites for 6–20 sites 3 sites >20 sites (sites with highest conc.)	Once every six days	Particle mass concentration indicated by sampler and by collocated sampler
Accuracy:				
Automated Methods for SO_2, NO_2, O_3, and CO	Response check at .03–.08 ppm[1,2] .15–.20 ppm[1,2] .35–.45 ppm[1,2] 80–.90 ppm[1,2] (if applicable)	1. Each analyzer 2. 25% of analyzers (at least 1)	1. Once per year 2. Each calendar quarter	Actual concentration [2] and measured (indicated) concentration [3] for each level
Manual Methods for SO_2, and NO_2	Check of analytical procedure with audit standard solutions	Analytical system	Each day samples are analyzed, at least twice per quarter	Actual concentration and measured (indicated) concentration for each audit solution
TSP, PM_{10}	Check of sampler flow rate	1. Each sampler 2. 25% of samplers (at least 1)	1. Once per year 2. Each calendar quarter	Actual flow rate and flow rate indicated by the sampler
Lead	1. Check of sample flow rate as for TSP 2. Check of analytical system with Pb audit strips	1. Each sampler 2. Analytical system	1. Include with TSP 2. Each quarter	1. Same as for TSP 2. Actual concentration and measured (indicated) concentration of audit samples (µg Pb/strip)
$PM_{2.5}$				
Manual and Automated Methods-Precision.	Collocated samplers	25% of SLAMS (monitors with Conc affecting NAAQS violation status)	Once every six days	1. Particle mass concentration indicated by sampler and by collocated sampler 2. 24-hour value for automated methods
Manual and Automated Methods-Accuracy and Bias	1. Check of sampler flow rate 2. Audit with reference method	25% of SLAMS (monitors with Conc affecting NAAQS violation status)	1. Minimum of every calendar quarter, 4 checks per year 2. Minimum 4 measurements per year	1. Actual flow rate and flow rate indicated by sampler 2. Particle mass concentration indicated by sampler and by audit reference sampler

[1] Concentration times 100 for CO.
[2] Effective concentration for open path analyzers.
[3] Corrected concentration, if applicable, for open path analyzers.

TABLE A-2.—SUMMARY OF $PM_{2.5}$ COLLOCATION AND AUDITS PROCEDURES AS AN EXAMPLE OF A TYPICAL REPORTING ORGANIZATION NEEDING 43 MONITORS, HAVING PROCURED FRMS AND THREE OTHER EQUIVALENT METHOD TYPES

Method Designation	Total # of Monitors	Total # Collocated	# of Collocated FRMs	# of Collocated Monitors of Same Type	# of Independent FRM Audits
FRM	25	6	6	n/a	6
Type A	10	3	2	1	3
Type C	2	1	1	0	1
Type D	6	2	1	1	2

m. Appendix C is amended by revising section 2.2 and adding sections 2.2.1 and 2.2.2, adding sections 2.4 through 2.5, revising section 2.7.1, and adding section 2.9 and references 4 through 6 to section 6.0 to read as follows:

Appendix C—Ambient Air Quality Monitoring Methodology

* * * * *

2.2 *Substitute PM_{10}* samplers.

2.2.1 For purposes of showing compliance with the NAAQS for particulate matter, a high volume TSP sampler described in 40 CFR part 50, Appendix B, may be used in a SLAMS in lieu of a PM_{10} monitor as long as the ambient concentrations of particles measured by the TSP sampler are below the PM_{10} NAAQS. If the TSP sampler measures a single value that is higher than the PM_{10} 24–hour standard, or if the annual average of its measurements is greater than the PM_{10} annual standard, the TSP sampler operating as a substitute PM_{10} sampler must be replaced with

Appendix 5

Supplementary Material for Chapter 5

Part G

Table of Relationship of Filter-based FRM PM10 and PM2.5 to Continuous Method

Appendix G. Relationship of filter-based FRM PM10 and PM2.5 to continuous methods for various sampling sites.

Samplers	Y = ax + b	R^2	# samples	study Period
Fresno Supersite				
SSI[1] - TEOM[2]10	Y = 0.83x - 9.8	0.95	10	1999 - 2000
SSI - BAM[3]10	Y = 1.108x - 23.24	0.76	10	1999 - 2000
RAAS[4] - BAM2.5	Y = 1.067x + 7.06	0.97	27	1999 - 2000
RAAS - TEOM2.5	Y = 0.418x + 3.17	0.31	27	1999 - 2000
Bakersfield, CA (Dutcher et al, 1999)				
SSI - BAM10	Y = 1.009x + 1.90	0.98	8	1998-1999
SSI - TEOM10	Y = 0.368x + 6.92	0.95	20	1998-1999
RAAS - BAM2.5win[5]	Y = 0.912x + 0.80	0.99	24	1998-1999
RAAS - BAM2.5scc[6]	Y = 0.97x + 3.25	0.99	24	1998-1999

[1] Size selective inlet, federal reference method
[2] Tapered element oscillating microbalance model 1400a operated @ 50^{o}C.
[3] Beta attenuation monitor model 1020
[4] Reference ambient air monitor for, federal reference method
[5] PM2.5 BAM with WINS impactor
[6] PM2.5 BAM with cyclone separator

Reference:

Dutcher D, Chung A, Kleeman M, Miller A, Perry K, Cahill T, Chang D. Instrument intercomparison study Bakersfield, CA, 1998-1999. Final report. Prepared for California Air Resources Board, Contract number 97-536, Delta Group, Department of Civil Engineering, University of California Davis and Department of Meteorology, San Jose State University.

Appendix 5

Supplementary Material for Chapter 5

Part H
Summary of PM Sampler Comparison Study at the Bakersfield Monitoring Station

The purpose of this study was to compare the performance of PM2.5 and PM10 continuous measurement methods to reference methods. Our intent was to identify PM2.5 and PM10 continuous analyzer(s) that can be used to determine compliance with the State ambient air quality standards (AAQS).

In response to a request by the Air Resources Board (a Board), the Office of Environmental Health and Hazard Assessment (OEHHA) and the ARB staff are reviewing the State PM standard. OEHHA has recommended retaining the current PM10 standard, revising the 24-hr and annual average values, and has proposed PM2.5 24-hr and annual standards. As a part of the PM standard review, ARB must describe the method by which particles will be measured and used to determine compliance with the AAQS. That activity resulted in staff reviewing the current PM10 State method (Method P), and identifying methods to measure PM2.5.

In the Board draft staff report, prepared for the Air Quality Advisory Committee, dated November 26, 2001, staff recommended the State adopt the PM10 and the PM2.5 Federal reference method (FRM) samplers that employ inertial impactors as methods suitable for determining compliance with the State standard. Staff also recommended the use of continuous PM10 and PM2.5 analyzers, if possible, that were being evaluated in Bakersfield, CA. Additional testing was necessary to capture the atmospheric conditions in the two areas with the most persistent particulate problems in California, the San Joaquin Valley and the South Coast Air Basin. The testing in Bakersfield adequately represents the conditions in both areas. Moreover, findings for this report needed to be based on a well-controlled study that eliminated vendor involvement, and that used an existing station with agency monitoring staff to operate the equipment. Other rigorous elements incorporated into the study included duplicate instrumentation for all instruments, extensive sample collection, multiple reference samplers, and audits by an outside entity of the candidate and reference devices.

Objectives

The study was conducted to compare the performance of advanced, commercially available continuous PM10 and PM2.5 analyzers to the performance of federal reference methods. These reference methods included duplicate hi-volume SSI and low-volume Partisol samplers for PM10, and the lo-volume RAAS for PM2.5. The resulting data were used to:

1) Determine whether any specific continuous monitoring method(s) is (are) acceptable for measuring PM10 and PM2.5 in California for the State Ambient Air Quality Standard.

2) Compare the common attributes of a lo-vol and hi-vol PM10. This objective was selected to evaluate the effect of using a hi-vol versus the lo-vol sampler as the 'subtractant' if one needed to calculate course mass (PM10-PM2.5).

Location of the Study

The study was conducted at the Air Resources Board monitoring station at 5558 California Avenue in Bakersfield, California. Located at the southern end of the Central Valley, the station is situated in a basin created by surrounding mountain ranges. Major activities in the region include oil productions, agricultural operations, and motor vehicle traffic. Bakersfield contains major roadways connecting Northern and Southern California.

Historical air quality data at Bakersfield shows that the winter season in the area sees high levels of air pollution due to emissions, topography, and meteorological conditions. Historically, during the winter months, this region is dominated by high PM concentrations. A large component of this PM consists of volatile compounds (nitrates and moisture).

Conducting the study in fall and winter in this location provided a wide range of meteorological and air quality conditions under which to test the instruments.

Instruments evaluated

Three types of PM10 and four types of PM2.5 continuous samplers were evaluated. Two of each type and size cut were operated for a total of 14 samplers.

The data from the continuous PM10 samplers were compared to two types of reference method, one hi-vol and one lo-vol. The PM2.5 continuous data were compared to the PM2.5 lo-vol reference method.

Reference method samplers

PM10
The Partisol model 2000 (Rupprecht and Patashnick [R&P] Partisol 2000; lo-vol) and the SSI model SA1200 (Thermo Andersen Inc; hi-vol) were the Federal Reference Method (FRM) samplers against which the PM10 continuous samplers were compared. A pair of Partisol PM10 FRMs were provided by R&P for the period of the study. The SSI was also operated in tandem at the site. It is currently the State method for PM10. These samplers are permanently placed at many stations by the ARB and local air districts. The mass of the PM in either instance is determined by pre- and post-weighing the sample filter. The mass concentration of PM is determined by dividing the collected mass by the total amount of air sampled.

PM2.5
The reference ambient air sampler (RAAS 2.5-300, Thermo Andersen Instruments), an FRM for PM2.5, was used to evaluate the accuracy of the

continuous PM2.5 samplers. This sampler consists of a PM10 inlet and a Wells Impactor Ninety-Six (WINS impactor), followed by a Teflon filter. The RAAS operates at 16.7 lpm. The WINS impactor is used to eliminate particles between PM10 and PM2.5 before they are collected on a 47-mm Teflon filter. The concentration of the PM is determined in the same manner as PM10, however using criteria contained in federal regulations specific to PM2.5.

Both lo-vol PM10 and PM2.5 FRMs used louvered PM10 inlets.

Continuous samplers

Four types of continuous samplers were evaluated in the study. All were lo-volume (16.67 lpm). Four samplers were provided by each vendor, two were configured to sample PM10, and two to sampler PM2.5. The participating samplers were the Thermo Andersen Beta Attenuation Monitor (BAM, model FH 62 C-14, here after called And-BAM), the Met One BAM (model 1020, here after called Met-BAM), and the Rupprecht and Patashnick (R&P) Filter Dynamics Measurement Systems (R&P FDMS series 8500). Also two PM2.5 Continuous Ambient Mass Monitor (CAMM) were provided by Thermo Andersen. Each PM10 device was equipped with louvered PM10 inlets and an inertial impactor. The instrument manufacturers assumed the responsibility for installing and calibrating their samplers. ARB staff provided space to the vendors at the air monitoring station. The representatives trained ARB staff and departed the site after they were confident the sampler was performing properly and the staff were suitably trained. The manufacturers' representatives handed over all aspects of the operation of the samplers to ARB staff for the duration of the study.

The PM2.5 samplers were equipped with a PM2.5 sharp cut cyclone (scc) to separate the PM2.5 fraction from the PM10. The cyclone is well suited for continuous operation

Beta Attenuation Monitors (BAM)

A beta attenuation monitor (BAM) consists of a lo-vol size selective inlet, a filter tape, a beta source, a beta ray detector, a lo-vol flow controller, and a timer. The sampler uses a source of beta radiation (^{14}C) and a detector to measure the beta absorption from PM accumulated on the filter tape. The filter material is a roll or cassette that advances automatically on a timed sequence. When particles are placed between the beta source and the detector, the beta rays are attenuated or absorbed by particles in their path. The difference in attenuation before and after the segment of the tape used to collect PM is attributed to the PM deposited on the filter. The reduction in beta ray intensity passing through the collected PM is a function of the mass of material between the source and the detector. The degree of beta radiation attenuation is converted to a PM concentration.

Thermo Andersen BAM (Model FH 62 C14)

The Thermo Andersen BAM (And-BAM) was equipped with an optional intermittent tube heater to reduce the relative humidity so that moisture does not condense on the filter. It performs simultaneous mass collection and measurement with continuous display of the current concentration. The single spot remains in the chamber for particle collection and measurement for 24-hr or until it is full (typ1500 $\mu g/m^3$), although the sampler has the ability of advancing the tape at a preset time. Calibration is accomplished with two calibration foils. It performs auto-zero check and is equipped with temperature sensor. It can measure PM mass as high as 5000 $\mu g/m^3$

Met One BAM (Model 1020)

The Met One BAM (Met-BAM) was also configured to eliminate water vapor from condensing on the filter. It automatically warmed the incoming air to 3°C above ambient. It has a sample time of 50 minutes per hour. The first and last five minutes of the sampling hour are used to calibrate, measure, and calculate the concentration of PM. The tape is automatically moved every hour. The sampler performs auto- zero/span check and is equipped with pressure and temperature sensors. It can measure PM mass as high as 1,000 mg/m^3.

Continuous Ambient Mass Monitor

The continuous ambient mass monitor (CAMM) based on a measure of pressure drop increase across a membrane filter with increasing particle loading on the filter. The analyzer consists of a diffusion dryer to remove particle-bound water and a filter tape to collect PM.

Filter Dynamics Measurement System (Series 8500)

The series 8500 Filter Dynamics Measurement System (FDMS) manufactured by R&P consists of an inlet, a sample filter, a dryer (sample equilibration system or SES), a microbalance, a purge filter conditioning unit, and a control unit. It uses a tapered oscillating microbalance that operates at 30^{o}C to measure the PM mass. It measures the PM mass and corrects for the volatile PM due to the elevated sampler temperature (30^{o}C), and reports the sum of non-volatile and non-volatile PM mass.

Study Period and Sampling Frequency

The study began on October 15, 2001, and ended January 31, 2002. During this period, the PM10 (SSI and Partisol) samplers and one of the PM2.5 (RAAS) filter-based samplers were operated one-in-three day schedule. The second RAAS was operated every day. All continuous analyzers were operated 24 hours a day, 7 days a week.

Data completeness

Data completeness (DC) is a measure of the number of available useable data to the total number of data possible for a single pollutant for a single site. Mathematically it is defined as:

%DC =

$$\left[\frac{total\ number\ samples\ possible - samples\ lost\ due\ to\ calibration\ and\ downtime}{total\ number\ of\ samples} \right] x100$$

For continuous data , there should be at least 18 or more hourly data of the maximum 24 and no more than 2 hours of consecutive hours data missing. The ARB strives for at least 85% DC. Data completeness was determined for both samplers not each one.

Using the above formula, the And-BAM PM10 and PM2.5 provided 86% and 96% DC (Table 1) respectively. The 4% incompleteness rate for PM2.5 was attributed to a wet filter due to roof leak at the sampler tube inlet. The collocated PM10 And-BAM sampler failed an audit on January 29, 2002. Because of this the data generated in January were discarded resulting in 86% DC. The CAMM had 96% DC, most of the 4% incompleteness was attributed to operator error.

The Met-BAM PM10 and PM2.5 samplers provided 90% and 97% DC respectively. Most of the data loss was because of pump problem and the samplers ran out of filter tapes during the weekend.

The FDMS PM10 and PM2.5 provided 92% and 87% DC respectively. The lower %DC of the PM2.5 FDMS (87%) and of the PM10 (92%) were attributed to either the clogging of the sample equilibration systems (dryers) or to the non-zero status provide by the samplers status output. Each of the FDMS samplers had had its dryer replaced once, the instrument provides an hourly status report (non-zero status code) whether the corresponding data is useable or not. Per manufacturer’s protocol, the data were considered valid only when the status values are zero. In addition to dryer replacement, data were invalidated due to non-zero status codes.

All samplers achieved the ARB goal for data completeness.

Table 1. Data completeness for samplers used at the Bakersfield sampler comparison study, 10/15/01 to 01/31/02

Samplers	hrs lost to cal	hrs lost to down time[1]	%DC
Thermo Andersen BAM-PM10	4	744	86
Thermo Andersen BAM-PM2.5	4	216	96
Thermo Andersen CAMM PM2.5	4	216	96
Met One BAM-PM10	5	144	90
Met One BAM-PM2.5	13	144	97
FDMS PM10	4	408	92
FDMS PM2.5	11	648	87

[1]includes instrument malfunction, environmental factors (e.g roof leak), operator error, and others

Methods of Data Analysis

To compare the performance of continuous samplers with the FRMs, first 24-hr averages were calculated for each continuous sampler. Then the average of the collocated samplers was compared with the average of the collocated FRMs. When one of the collocated continuous samplers did not produce enough data to produce 24-hr average, the 24-hr average of a single sampler was used for comparison. For precision, daily averages of collocated samplers were compared.

Precision of the FRMs was determined using the equations described in 40CFR Part 58 (Federal Register, 1997). The equations are given below. First the percent difference of each pair of 24-hr average data was calculated using equation 1.

Equation 1

$$di = \left(\frac{sampler1 - \ sampler2}{Average\ of\ \ (sampler1\ and\ \ sampler2)} \right) X\ 100$$

For a given sampler j, the average of the individual percentage difference during the study can be calculated using.

Equation 2

$$D_{j,q} = \frac{1}{n_{j,q}}\ x \sum_{i=1}^{n_{j,q}} d'_i$$

Where $n_{j,q}$ the number of sample pairs measured during the study. Also, regression analysis of collocated samplers was determined to evaluate the extent of agreement of the two.

To assess the accuracy of the continuous samplers, the averages of continuous PM10 samplers' data were compared with the averages of PM10 Partisol and SSI FRMs. Because of the similarity of flow rate and filter size, the daily averages of the PM10 continuous samplers were compared with the averages of Partisol sampler for accuracy. The averages of continuous PM2.5 samplers' data were compared with the averages of PM2.5 RAAS FRM. A regression analysis of the FRM to each continuous sampler was used to determine a slope, intercept, and correlation.

PM10 sampler comparison

Results of comparisons of PM10 samplers are given in Table 2. The FRMs are the lo-vol Partisol and the hi-vol SSI. Each was evaluated for precision using collocated samplers. The average of collocated Partisol was used to compare with average of collocated continuous samplers for accuracy.

Table 2. PM10 samplers comparison

X	Y	Intercept (ug/m3)	slope	r[1]	# samples
Precision					
Partisol[2]	Partisol	0.26	0.99	1.0	32
SSI[2]	SSI	0.18	1.01	1.0	32
And-BAM[3]	And-BAM	0.86	1.0	0.98	108
Met-BAM[4]	Met BAM	-1.63	0.97	1.0	97
FDMS[5]	FDMS	17.14	1.04	0.93	91
Accuracy					
Partisol	SSI	2.57	0.96	1.0	32
Partisol	And-BAM	-2.50	1.04	0.99	34
Partisol	Met BAM	-1.65	1.13	1.0	32
Partisol	FDMS	1.08	1.05	0.97	30

[1]r = correlation
[2]Partisol and SSI (size selective inlet) are Federal Reference Methods for PM10 manufactured by Rupprecht and Patashnick Co., Inc. and Thermo Andersen respectively
[3]And- BAM = Thermo Andersen BAM model FH 62 C14 manufactured by Thermo Andersen, Inc.
[4]Met BAM = Met One BAM model 1020 manufactured by Met One Instruments, Inc.
[5]FDMS = Filter Dynamics Measurement Systems series 8500 manufactured by Rupprecht and Patashnick Co.,

FRMs

The precision of the samplers, two Partisols (slope = 0.99, correlation 1.0, and intercept 0.26) and the two SSIs (slope = 1.01, correlation 1.0, and intercept 0.18) was excellent. Calculating the precision of each sampler type using equations 1 and 2 above, the Partisol and SSI have precision values of 0.7% and 1% respectively (Table 3).

The agreement of the lo-vol Partisol with the high-vol SSI also shows excellent agreement (r = 1.0) with the slope and intercept of 0.96 and 2.57 respectively. Continuous samplers

Regression analysis of the collocated continuous And-BAM (slope 1.0, intercept 0.86, and correlation 0.98), Met-BAM (slope 0.97, intercept -1.63, and correlation 1.0), and the FDMS (slope 1.04, intercept 17.14, and correlation 0.93) yielded good agreement between pairs.

Table 3. Daily precision for both PM2.5 and PM10 samplers.

	------------Precision (%)-------------	
	PM10	PM2.5
SSI	1	_
Partisol	0.7	_
RAAS	_	4

Comparison of the Partisol to the And-BAM, Met-BAM, and the FDMS resulted in slope values of (1.04, 1.13, and 1.05 respectively), correlation values (0.99, 1.0, and 0.97, respectively), and intercepts (-2.50, -1.65, and 1.08, respectively) which indicate agreement between the continuous sampler and the FRM within the criteria for a California Approved Sampler. (Table 2). Thirty or more data pairs were used for comparison.

PM2.5 sampler comparison

The comparison of RAAS PM2.5 FRM to continuous PM2.5 shown in Table 4 indicates excellent inter and intra sampler agreement for the PM2.5 samplers.

Regression analysis of the collocated RAAS yielded a slope of 0.98, correlation of 1.0, and an intercept of -0.57 showing very good agreement between pairs. Similarly the collocated And-BAM (slope 0.98, correlation 0.98, and intercept 0.69), the Met-BAM (slope 0.98, correlation 1.0, and intercept -1.19), the FDMS (slope 1.04, correlation 0.99, and intercept, 0.88), and the CAMM (slope 0.97, correlation 0.91, and intercept 2.32) (Table 4) agree well with each other. When calculated using equations 1 and 2, the RAAS has precision value of 4% (Table 3).

Table 4. PM2.5 samplers comparison

X	Y	Intercept	slope	r[1]	# samples
Precision					
RAAS[2]	RAAS	-0.57	0.98	1.0	33
And-BAM[3]	And-BAM	0.69	0.98	0.98	99
Met-BAM[4]	Met BAM	-1.19	0.98	1.0	105
FDMS[5]	FDMS	0.88	1.04	0.99	55
CAMM[6]	CAMM	2.32	0.97	0.91	96
Accuracy					
RAAS	And-BAM	-1.32	1.02	0.98	102
RAAS	Met-BAM	-1.58	1.03	1.0	102
RAAS	FDMS	3.73	1.01	0.99	102
RASS	CAMM	9.79	0.68	0.87	93

[1] r = correlation
[2] RAAS = Reference Ambient Air Monitor is a Federal reference method for PM2.5
[3] And- BAM = Thermo Andersen BAM model FH 62 C14 manufactured by Thermo Andersen Inc.
[4] Met BAM = Met One BAM model 1020 manufactured by Met One Instruments, Inc.
[5] FDMS = Filter Dynamic Measurement Systems, series 8500 manufactured by Rupprecht and Patashnick Co.
[6] CAMM = Continuous Ambient Mass Monitor manufactured by the Thermo Andersen Inc.

Continuous Samplers

The accuracy of a PM2.5 continuous sampler was determined by comparing 24-hr average data with the RAAS PM2.5 FRM (Table 4). The values of the slopes (1.02, 1.03, and 1.01 respectively), correlation (0.98, 1.0, and 0.99 respectively), and intercepts (-1.32, -1.58, and 3.73 respectively) indicate good accuracy for the And-BAM, the Met-BAM, and the FDMS respectively. For CAMM, slope of 0.68, correlation of 0.87, and intercept of 9.79 indicate poor agreement with the FRM.

Criteria for Acceptability as California Approved Samplers

The criteria used by the U.S.EPA for determining acceptability of PM10 equivalent samplers, seen below as PM10 Class II, were adopted by staff as the criteria for selecting California Approved Samplers. The criteria have been used successfully by the U.S EPA to approve a large number of samplers that are used throughout the country. We find the criteria suitable provided the tests are conducted in California and under conditions typical of areas with large populations and with persistent PM problems.

The U.S. EPA promulgated more stringent criteria in the PM2.5 regulations for PM2.5 equivalency. The new levels have been seen as quite stringent, to the point that the PM2.5 reference sampler, when compared to itself, often fails the test. They have been characterized as unnecessarily stringent, particularly in light of the increased number of data values available from continuous instruments. That feature is discussed below. It is interesting to note, however, that all samplers in the California Approved Sampler Study, except one, would have passed the more stringent PM2.5 criteria. The one that did not pass, failed only slightly with a slightly elevated y-intercept.

The U.S. EPA is developing other techniques for inter-sampler comparisons that are designed to take full advantage of the power of the increased sampling frequency of continuous samplers versus the intermittent schedule of filter based measurements. The EPA has found that the increased sampling frequency from continuous samplers would allow them to relax the nominal level of the acceptance criteria without lessening the effectiveness of the current comparative test.

Staff are following the evolving developments being discussed by the U.S.EPA , however, have selected a more stringent criteria for the California Approved Sampler at this time. The criteria have a history of being accepted by the measurement community and reliable if sampling conditions are regulated.

Table 5. Criteria for PM10 and PM2.5 (40CFR 53 Table C-1)

	PM10 Class II	PM2.5 Class II
Precision of replicate reference	5 $\mu g/m^3$ or 7%	2 $\mu g/m^3$ or 5%
Slope	1 ± 0.1	1 ± 0.05
Intercept ($\mu g/m^3$)	0 ± 5	0 ± 1
Correlation (r)	≥ 0.97	≥ 0.97

Conclusions

The staff proposes to use the accuracy and precision criteria stated in federal regulation as the U.S. EPA PM10 class II test specifications as the State's criteria for determining acceptability of a California Acceptable Sampler for PM10 and PM2.5.

For both PM2.5 and PM10, three of the four samplers evaluated in the study--the Thermo Andersen BAM (model FH 62 C14), the Met One BAM (model 1020), and the R&P FDMS (series 8500) satisfy the criteria. Consequently, staff recommends that these samplers be approved for use to measure PM mass for determining compliance with the existing and proposed State AAQS.

Appendix 5

Supplementary Material for Chapter 5

Part I
Table of the State of California PM10 and PM2.5 Monitoring List

Appendix I. State of California PM10 and 2.5 Monitoring List

SITE	PM10	PM2.5	TEOM	PARTISOL	BAM
GREAT BASIN VALLEYS AIR BASIN**					
Bishop				R&P 2000-PM10	
Cosco Junction-Gill Station				R&P 2000-PM10	
Dirty Socks			R&P 1400A	R&P 2025-PM10	
Keeler-Cerro Gordo Road	SA 1200	R&P 2025	R&P 1400A	2000-PM10 2025-PM 2.5	
Lee Vining-SMS				R&P 2000-PM10	
Lone Pine-E. Locust Street			R&P 1400A	2000-PM10	
Mammoth Lakes				R&P 2000-PM10	
Mono Lake-Simis Residence				R&P 2000-PM10	
Mono Shore				R&P 2000-PM10	
Olancha-Walker Creek Road			R&P 1400A	2000-PM10	
Shell Cut			R&P 1400A	2025-PM10	
LAKE COUNTY AIR BASIN					
Glenbrook	X				
Lakeport-Lakeport Blvd.	SA 1200	X			
LAKE TAHOE AIR BASIN					
Cave Rock	SA 1200	ANDERSEN 300			
Echo Summit	SA 1200	ANDERSEN 400			
Incline Village		ANDERSEN 300			
South Lake Tahoe-Sandy Way	SA 1200	R&P 2000			
MOJAVE DESERT AIR BASIN					
Barstow	SA 1200				
China Lake-Powerline Road	SA 1200				
Hesperia-Olive Street	SA 1200				
Lancaster-W. Pondera Street	SA 1200	ANDERSEN 100	R&P 1400A		
Lucerne Valley Middle School	SA 1200				
Mojave-923 Poole Street	SA 1200	ANDERSEN RAAS			
Ridgecrest-California Ave	SA 1200	ANDERSEN RAAS			
Trona-Athol Telegraph	SA 1200		R&P 1400A		
Twentynine Palms-Adobe Road #2	SA 1200				
Victorville-Armagosa Road	SA 1200	X			
Victorville - Park	SA1200	ANDERSEN 300	R&P 1400A		MET ONE PM 2.5
MOUNTAIN COUNTIES AIR BASIN					
Chester-222 1st Avenue	SA 1200				
Grass Valley-Henderson Street	WEDDING				
GV-Litton Building		R&P 2000-H	R&P 1400A		
Loyalton-W 3rd Street	SA 1200				
Placerville-Gold Nugget Way	SA 1200				
Portola-Commercial Street	SA 1200	ANDERSEN 300			
Quincy-N Church Street		ANDERSEN 300	R&P 1400A		
San Andreas-Gold Strike Road	SA 1200	R&P 2000H			
Truckee-Fire Station	SA 1200	X	R&P 1400A		
Yosemite Village-Visitor Center	SA 1200				
NORTH CENTRAL COAST AIR BASIN					
Carmel Valley-Ford Road	SA 1200				
Davenport	SA 1200				
Hollister-Fairview Road	SA 1200				
Moss Landing-Sandholt Road	SA 1200				
Salinas-#3	SA 1200	ANDERSEN 300			
Santa Cruz-2544 Soquel Avenue	SA 1200	R&P 300			
Watsonville-Airport Boulevard	SA 1200				
NORTH COAST AIR BASIN					
Cloverdale	SA 1200		R&P 1400A		

Crescent City, 880 Northcrest Drive	SA 1200				
Eureka-Health Dept 6th and I Street	WEDDING	X			
Fort Bragg-N.Franklin Street	SA 1200				
Guerneville-Church and 1st	SA 1200				
Healdsburg-133 Matheson Street	SA 1200				
Ukiah-County Library	SA 1200	R&P2000H			
Weaverville-Courthouse	SA 1200				
Willits-Firehouse	SA 1200				
NORTHEAST PLATEAU AIR BASIN					
Alturas-W 4th Street	SA 1200	X			
Lava Beds Natl Monument	SA 1200				
Mount Shasta-N Old Stage Road	SA 1200				
Susanville-Russel	SA 1200				
Yreka-Foothill Drive	SA 1200	X			
SACRAMENTO VALLEY AIR BASIN					
Anderson-North Street	SA 1200		R&P 1400A		
Chico-Manzanita Avenue	SA 1200	R&P 2000	R&P 1400A		
Colusa-Sunrise Blvd	SA 1200	ANDERSEN 300	R&P 1400A		
North Highlands-Blackfoot Way	SA 1200				
Red Bluff-Messer Road	SA1200				
Rocklin	GRASEBY1200		R&P 1400A		MET ONE PM10
Roseville-N Sunrise Blvd	SA1200	R&P 2000			
Sacramento-3801 Airport Road	SA 1200		R&P 1400A		
Sacramento-Branch Center Road	SA 1200				
Sacramento-Del Paso Manor	SA 1200	ANDERSEN 300	R&P 1400A		MET ONE PM10
Sacramento-Health Dept Stockton Blvd	SA 1200	ANDERSEN 300	R&P 1400A		
Sacramento -T Street	SA 1200	ANDERSEN 300	R&P 1400A		MET ONE PM2.5
Vacaville-Emira Road	X				
Vacaville-Merchant Street	SA 1200				
Willows-E Laurel Street	GMW 1200		R&P 1400A		
West Sacramento-15th Street	WEDDING				
Woodland-Gibson Road	GRASEBY 1200	ANDERSEN 300			MET ONE PM10
Yuba City-Almond Street	SA 1200	R&P 2000	R&P 1400A		
SALTON SEA AIR BASIN					
Brawley-Main Street	SA 1200	ANDERSEN 300			
Calexico-East	X		R&P 1400A		
Calexico-Ethel Street	SA 1200	ANDERSEN 300			MET ONE PM2.5
Calexico-Grant Street	SA 1200				
El Centro-9th Street	SA 1200	ANDERSEN 300			
Indio-Jackson Street	SA 1200	ANDERSEN RAAS2			MET ONE PM10 and PM 2.5
Niland-English Road	SA 1200				
Palm Springs-Fire Station	GRASEBY	ANDERSEN RAAS2			MET ONE PM10 and PM 2.5
Westmorland-W 1st Street	SA 1200				
Winterhaven	X				
SAN DIEGO AIR BASIN					
Chula Vista	SA 1200	ANDERSEN RAAS2			
El Cajon-Redwood Avenue	SA 1200	ANDERSEN 300			
Escondido-E Valley Parkway	SA 1200	ANDERSEN 300			MET ONE PM2.5
Otay Mesa-Paseo International	SA1200				
San Diego-12th Avenue	SIERRA ANDERSEN	ANDERSEN RAAS2			
San Diego-Overland Avenue	SA 1200	RAAS 3000			
SAN FRANCISCO BAY AREA AIR BASIN					
Bethel Island Road	SA1200				
Concord-2975 Treat Blvd	X	ANDERSEN 300			

Fremont-Chapel Way	SA 1200	GRASEBY ANDERSEN			
Livermore-Old 1st Street	SA 1200		R&P 1400A		
Napa-Jefferson Avenue	SA1200				
Point Reyes					MET ONE PM 2.5
Redwood City	SA 1200	ANDERSEN 300			
San Francisco-Arkansas Street	SA1200	ANDERSEN 300			MET ONE PM10
San Jose-4th Street	SIERRA ANDERSEN	RAAS 2.5			MET ONE Pm10 and PM 2.5
San Jose-Tully Road	SA1200	GRASEBY ANDERSEN			
San Rafael	SA 1200				
Santa Rosa-5th Street	SA1200	ANDERSEN 300			
Vallejo-304 Tuolumne Street	SA1200	GRASEBY ANDERSEN			
SAN JOAQUIN VALLEY AIR BASIN					
Bakersfield Airport		ANDERSEN 300			
Bakersfield-California Avenue	SIERRA ANDERSEN AND GRASEBY ANDERSEN	ANDERSEN RAAS	R&P 1400A		
Bakersfield-Golden State Highway	SA1200	X			
Clovis-N Villa Avenue	SA 1200	RAAS2	R&P 1400A		
Corcoran-Patterson Avenue	SA1200	ANDERSEN 300	R&P 1400A		
Fresno-1st Street	SA 1200	ANDERSEN 300	R&P 1400A		
Fresno-Drummond Street	SA1200				
Fresno Pacific		ANDERSEN 300			
Hanford-S Irwin Street	SA1200		R&P 1400A		
Merced M Street	SA 1200	GA RAAS 2.5-30			
Modesto-14th Street	SA1200	ANDERSEN 300	R&P 1400A		
Oildale-3311 Manor Street	SA1200				
Stockton-Hazelton Street	SA1200	ANDERSEN 300	R&P 1400A		
Stockton-Wagner-Holt School	SA1200		R&P 1400A		
Taft College	SA1200				
Turlock-s Minaret Street	SA1200				
Visalia-N Church Street	SA1200	ANDERSEN 300			
SOUTH CENTRAL COAST AIR BASIN					
Arroyo Grande-Ralcoa Way	SA1200				
Atascadero-Lewis Avenue	SA1200	FRM2000	R&P 1400A		
El Capitan Beach	SA1200				
EL Rio-Rio Mesa School #2	SA1200	X			
Las Flores Canyon #1	SA1200				
Lompoc Constellation			R&P 1400A		
Lompoc-S H Street	SA1200				
Morro Bay	SA1200				
Nipomo-Guadalupe Road	SA1200				
Nipomo-Teft & Pomeroy Streets	SA1200				
Ojai-Ojai Avenue	SA1200				
Paso Robles-Santa Fe Avenue	SA1200				
Piru-2 miles SW	X	X			
San Luis Obispo- Marsh Street	SA1200	R&P 2000H			
Santa Barbara-W Carillo Street	SA1200			R&P 2025	
Santa Maria-South Broadway	SA1200	R&P 2000H	R&P 1400A	R&P 2000	
Simi Valley-Cochran Street	SA1200	ANDERSEN 300			
Thousand Oaks-Moorpark School	SA1200	RAAS			
Vandenberg Air Force Base-STS Power	SA1200				
SOUTH COAST AIR BASIN					
Anaheim-Harbor Blvd	SA1200	ANDERSEN 300			MET ONE PM10

Azuza	SA1200	ANDERSEN 300	R&P 1400A		MET ONE PM10
Banning Airport	SA1200				
Banning-Allesandro	SA1200				
Banning-South Hathaway Street	SA1200				
Burbank-W Palm Avenue	SA1200	RAAS	R&P 1400A		
Fontana-Arrow Highway	SA1200	ANDERSEN 300			
Glendora			R&P 1400A		MET ONE PM2.5
Hawthorne	SA1200	X			
Lake Arrowhead			R&P 1400A		
Lake Elsinore			R&P 1400A		
Lake Forest	X	X	X		
Los Angeles-North Main Street	SA1200	ANDERSEN 300			MET ONE PM10
Lynwood		ANDERSEN RAAS			
Mira Loma			R&P 1400A		
Mission Viejo	X	ANDERSEN 300			
North Long Beach	SA1200	RAAS	R&P 1400A		MET ONE PM10
Ontario Airport	SA1200				
Perris	SA1200				
Norco-Norconian	SA1200				
Redlands-Dearborn	SA1200				
Riverside-Magnolia		ANDERSEN 300			
Riverside-Rubidoux	SA1200	ANDERSEN 300	R&P 1400A		MET ONE PM10
San Bernardino-4th Street	SA1200	ANDERSEN 300			
Santa Clarita-County Fire Station	SA1200				
UC Riverside			R&P 1400A		
Upland			R&P 1400A		
MEXICO					
Mexicali-CBTIS	WEDDING				
Mexicali-Cobach	SA1200				
Mexicali-Conalep	SA1200				
Mexicali-ITM	SA1200				
Mexicali-Progreso	SA1200				
Mexicali-UABC	SA1200		R&P 1400A		
Rosarito	SA1200				
Tecate-Paseo Morelos	SA1200				
Tijuana-Center of Health #1	SA1200				
Tijuana-colef	SA1200				
Tijuana-Itt	SA1200				
Tijuana-La Mesa	SA1200				
Tijuana-Las Playas	SA1200				

Appendix 6

Supplementary Material for Chapter 6

Part A
PM10 Air Quality Data

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
Great Basin Valleys	Inyo	Coso Junction-10 miles E	060271014	1998	246	64	49	42			54	95
Great Basin Valleys	Inyo	Coso Junction-Highway 395 Rest Area	060271001	2000	74	65	58	55	10	15	110	93
Great Basin Valleys	Inyo	Coso Junction-Highway 395 Rest Area	060271001	1999	46	36	34	33	12	14	115	100
Great Basin Valleys	Inyo	Coso Junction-Highway 395 Rest Area	060271001	1998	409	91	64	34	13	23	59	95
Great Basin Valleys	Inyo	Keeler-Cerro Gordo Road	060271003	2000	715	181	148	83	19	39	59	97
Great Basin Valleys	Inyo	Keeler-Cerro Gordo Road	060271003	1998	1116	590	506	372	20	51	83	94
Great Basin Valleys	Inyo	Keeler-Cerro Gordo Road	060271003	1999	514	377	131	130			64	63
Great Basin Valleys	Inyo	Lone Pine-E Locust Street	060270004	1999	44	25	25	24	14	15	60	100
Great Basin Valleys	Inyo	Lone Pine-E Locust Street	060270004	2000	52	51	43	42	16	18	60	99
Great Basin Valleys	Inyo	Lone Pine-E Locust Street	060270004	1998	275	171	117	111			54	93
Great Basin Valleys	Inyo	Olancha-Walker Creek Road	060270021	1998	173	56	45	37	9	14	60	98
Great Basin Valleys	Inyo	Olancha-Walker Creek Road	060270021	1999	103	44	35	29	12	15	59	99
Great Basin Valleys	Inyo	Olancha-Walker Creek Road	060270021	2000	176	70	56	38	15	20	59	97
Great Basin Valleys	Mono	Lee Vining-SMS	060510005	1999	40	30	29	28	11	13	106	99
Great Basin Valleys	Mono	Lee Vining-SMS	060510005	2000	62	38	31	31	12	13	113	100
Great Basin Valleys	Mono	Lee Vining-SMS	060510005	1998	48	40	27	27			47	84
Great Basin Valleys	Mono	Mammoth Lakes-Gateway HC	060510001	1998	106	67	52	49			37	48
Great Basin Valleys	Mono	Mammoth Lakes-Gateway HC	060510001	2000	70	52	50	48			18	38
Great Basin Valleys	Mono	Mono Lake North Shore	060510011	2000	3059	1642	1513	1063			264	84
Great Basin Valleys	Mono	Mono Lake-Simis Residence	060510007	1998	45	25	24	19	7	9	57	91
Great Basin Valleys	Mono	Mono Lake-Simis Residence	060510007	2000	97	54	50	42	8	13	92	90
Great Basin Valleys	Mono	Mono Lake-Simis Residence	060510007	1999	133	33	32	32			98	88
Lake County	Lake	Lakeport-Lakeport Blvd	060333001	2000	22	21	20	19	10	11	61	100
Lake County	Lake	Lakeport-Lakeport Blvd	060333001	1998	35	22	21	16			57	90
Lake County	Lake	Lakeport-Lakeport Blvd	060333001	1999	43	40	36	32			55	93
Lake Tahoe	El Dorado	Echo Summit	060170012	2000	21	20	18	18	7	9	62	100
Lake Tahoe	El Dorado	South Lake Tahoe-Sandy Way	060170011	1999	41	39	34	32	17	20	58	94
Lake Tahoe	El Dorado	South Lake Tahoe-Sandy Way	060170011	2000	50	50	47	47	18	20	61	100
Lake Tahoe	El Dorado	South Lake Tahoe-Sandy Way	060170011	1998	59	53	47	46	20	23	56	92
Mojave Desert	Kern	China Lake-Powerline Road	060291001	2000	53	38	34	30			55	90
Mojave Desert	Kern	China Lake-Powerline Road	060291001	1999	28	28	27	24			50	79
Mojave Desert	Kern	China Lake-Powerline Road	060291001	1998	165	84	38	32			41	53
Mojave Desert	Kern	Mojave-923 Poole Street	060290011	1998	41	37	35	33	13	16	60	96
Mojave Desert	Kern	Mojave-923 Poole Street	060290011	1999	45	34	34	33	17	19	61	90
Mojave Desert	Kern	Mojave-923 Poole Street	060290011	2000	44	43	39	37			57	85
Mojave Desert	Kern	Ridgecrest-100 West California Avenue	060290015	2000	90	52	48	45	18	22	61	97
Mojave Desert	Los Angeles	Lancaster-W Pondera Street	060379002	1999	85	51	50	44	26	29	58	95
Mojave Desert	Los Angeles	Lancaster-W Pondera Street	060379002	1998	80	58	48	46			52	85
Mojave Desert	San Bernardino	Barstow	060710001	1998	53	48	42	41			53	80
Mojave Desert	San Bernardino	Barstow	060710001	1999	69	49	45	41			54	87
Mojave Desert	San Bernardino	Barstow	060710001	2000	69	57	48	48			55	90
Mojave Desert	San Bernardino	Hesperia-Olive Street	060714001	1999	109	66	66	58	28	32	60	98
Mojave Desert	San Bernardino	Hesperia-Olive Street	060714001	1998	70	64	51	50			58	93
Mojave Desert	San Bernardino	Hesperia-Olive Street	060714001	2000	80	60	56	55			59	99
Mojave Desert	San Bernardino	Lucerne Valley-Middle School	060710013	2000	58	50	49	46	19	23	58	90
Mojave Desert	San Bernardino	Lucerne Valley-Middle School	060710013	1998	39	39	37	34			54	90
Mojave Desert	San Bernardino	Lucerne Valley-Middle School	060710013	1999	95	43	38	38			58	93
Mojave Desert	San Bernardino	Trona-Athol and Telegraph	060711234	2000	58	49	41	35	15	18	58	89
Mojave Desert	San Bernardino	Trona-Athol and Telegraph	060711234	1999	44	29	28	28			57	91
Mojave Desert	San Bernardino	Trona-Athol and Telegraph	060711234	1998	53	48	39	38			56	86
Mojave Desert	San Bernardino	Twentynine Palms-Adobe Road #2	060710017	1998	30	30	29	27	14	16	58	96

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
Mojave Desert	San Bernardino	Twentynine Palms-Adobe Road #2	060710017	2000	62	46	39	39	18	21	61	97
Mojave Desert	San Bernardino	Twentynine Palms-Adobe Road #2	060710017	1999	105	61	53	51			56	93
Mojave Desert	San Bernardino	Victorville-Armagosa Road	060710014	1999	78	76	64	47	27	31	59	96
Mojave Desert	San Bernardino	Victorville-Armagosa Road	060710014	2000	52	46	45	37			20	10
Mojave Desert	San Bernardino	Victorville-Armagosa Road	060710014	1998	70	48	47	45			56	94
Mountain Counties	Calaveras	San Andreas-Gold Strike Road	060090001	1998	35	35	29	27	14	16	56	90
Mountain Counties	Calaveras	San Andreas-Gold Strike Road	060090001	2000	35	33	32	31	16	18	63	95
Mountain Counties	Calaveras	San Andreas-Gold Strike Road	060090001	1999	65	64	42	39	18	21	58	95
Mountain Counties	El Dorado	Placerville-Gold Nugget Way	060170010	1998	41	38	29	28	13	15	61	100
Mountain Counties	El Dorado	Placerville-Gold Nugget Way	060170010	1999	49	41	41	41	16	18	58	89
Mountain Counties	El Dorado	Placerville-Gold Nugget Way	060170010	2000	38	33	30	29			57	88
Mountain Counties	Mariposa	Yosemite Village-Visitor Center	060431001	1998	40	39	37	37			55	83
Mountain Counties	Mariposa	Yosemite Village-Visitor Center	060431001	2000	98	60	56	49			59	91
Mountain Counties	Mariposa	Yosemite Village-Visitor Center	060431001	1999	82	74	47	46			55	84
Mountain Counties	Nevada	Grass Valley-Henderson Street	060570001	1998	43	34	29	28	13	14	60	99
Mountain Counties	Nevada	Grass Valley-Henderson Street	060570001	1999	42	31	23	21			17	30
Mountain Counties	Nevada	Truckee-Fire Station	060571001	1998	71	62	57	51	22	25	60	95
Mountain Counties	Nevada	Truckee-Fire Station	060571001	2000	50	49	25	24			19	11
Mountain Counties	Nevada	Truckee-Fire Station	060571001	1999	82	64	62	60			48	77
Mountain Counties	Nevada	Truckee-Glenshire Fire Station	060570004	2000	57	42	39	28			18	11
Mountain Counties	Nevada	Truckee-Glenshire Fire Station	060570004	1999	84	69	44	42			54	90
Mountain Counties	Nevada	Truckee-Glenshire Fire Station	060570004	1998	92	66	52	41			35	50
Mountain Counties	Plumas	Chester-222 1st Avenue	060631007	1999	70	67	64	54	23	25	60	100
Mountain Counties	Plumas	Chester-222 1st Avenue	060631007	1998	65	56	51	47	23	25	60	94
Mountain Counties	Plumas	Chester-222 1st Avenue	060631007	2000	44	30	26	26			20	9
Mountain Counties	Plumas	Portola-161 Nevada Street	060631009	2000	75	53	44	44			16	4
Mountain Counties	Plumas	Quincy-N Church Street	060631006	1998	74	43	40	34	18	20	60	100
Mountain Counties	Plumas	Quincy-N Church Street	060631006	2000	73	58	56	53			59	87
Mountain Counties	Plumas	Quincy-N Church Street	060631006	1999	125	96	96	76			55	98
Mountain Counties	Sierra	Loyalton-W 3rd Street	060910001	1999	68	53	50	46	22	25	58	96
Mountain Counties	Sierra	Loyalton-W 3rd Street	060910001	2000	39	32	32	29			20	12
Mountain Counties	Sierra	Loyalton-W 3rd Street	060910001	1998	60	55	53	41			57	86
North Central Coast	Monterey	Carmel Valley-Ford Road	060530002	1998	28	27	26	25	11	12	62	97
North Central Coast	Monterey	Carmel Valley-Ford Road	060530002	2000	27	21	21	19	12	13	59	98
North Central Coast	Monterey	Carmel Valley-Ford Road	060530002	1999	57	39	38	34			60	98
North Central Coast	Monterey	King City-750 Metz Road	060530005	1999	65	57	47	47	18	22	59	98
North Central Coast	Monterey	King City-750 Metz Road	060530005	1998	36	35	33	32			34	64
North Central Coast	Monterey	King City-750 Metz Road	060530005	2000	47	44	39	35			45	66
North Central Coast	Monterey	Moss Landing - Sandholt Road	060530007	1998	52	50	50	47	26	27	60	92
North Central Coast	Monterey	Moss Landing - Sandholt Road	060530007	1999	91	76	46	46	27	29	60	100
North Central Coast	Monterey	Moss Landing - Sandholt Road	060530007	2000	74	70	68	52			60	99
North Central Coast	Monterey	Salinas-High School	060531003	2000	36	34	31	30			56	94
North Central Coast	Monterey	Salinas-Natividad Road #2	060531002	1998	52	46	44	40	16	18	61	98
North Central Coast	Monterey	Salinas-Natividad Road #2	060531002	1999	50	48	46	42	18	20	60	100
North Central Coast	Monterey	Salinas-Natividad Road #2	060531002	2000	29	19	12	11			6	5
North Central Coast	San Benito	Hollister-Fairview Road	060690002	1998	37	36	36	35	14	16	59	95
North Central Coast	San Benito	Hollister-Fairview Road	060690002	2000	40	31	27	26	14	16	60	99
North Central Coast	San Benito	Hollister-Fairview Road	060690002	1999	67	50	50	48			58	96
North Central Coast	Santa Cruz	Davenport	060870003	2000	50	50	48	46	24	26	61	95
North Central Coast	Santa Cruz	Davenport	060870003	1998	76	67	60	54	26	28	60	99
North Central Coast	Santa Cruz	Davenport	060870003	1999	103	75	58	57	28	31	59	98

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
North Central Coast	Santa Cruz	Santa Cruz-2544 Soquel Avenue	060870007	2000	30	30	30	29	14	16	62	99
North Central Coast	Santa Cruz	Santa Cruz-2544 Soquel Avenue	060870007	1998	34	33	32	32	16	17	61	96
North Central Coast	Santa Cruz	Santa Cruz-2544 Soquel Avenue	060870007	1999	47	44	37	37	17	19	60	100
North Central Coast	Santa Cruz	Watsonville-Airport Boulevard	060870004	2000	36	36	32	31	16	17	61	100
North Central Coast	Santa Cruz	Watsonville-Airport Boulevard	060870004	1998	46	41	41	36	17	18	60	98
North Central Coast	Santa Cruz	Watsonville-Airport Boulevard	060870004	1999	49	47	46	43	18	21	60	100
North Coast	Del Norte	Crescent City, 880 Northcrest Drive	060150006	1999	39	39	37	36	15	17	59	88
North Coast	Del Norte	Crescent City, 880 Northcrest Drive	060150006	2000	44	36	31	28	16	17	55	85
North Coast	Del Norte	Crescent City, 880 Northcrest Drive	060150006	1998	33	33	24	23			48	75
North Coast	Del Norte	Crescent City-9th and H Street	060150004	1998	48	33	32	31			14	23
North Coast	Humboldt	Eureka-Health Dept 6th and I Street	060231002	1998	43	40	34	32	13	15	58	89
North Coast	Humboldt	Eureka-Health Dept 6th and I Street	060231002	1999	57	50	45	42	16	19	59	94
North Coast	Humboldt	Eureka-Health Dept 6th and I Street	060231002	2000	51	46	45	44	18	21	64	90
North Coast	Mendocino	Fort Bragg-N Franklin Street	060450002	1998	50	39	38	36	20	21	60	98
North Coast	Mendocino	Fort Bragg-N Franklin Street	060450002	2000	49	47	44	43	20	22	61	98
North Coast	Mendocino	Fort Bragg-N Franklin Street	060450002	1999	66	66	45	40			55	91
North Coast	Mendocino	Ukiah-County Library	060450006	1998	46	29	27	27	13	14	60	93
North Coast	Mendocino	Ukiah-County Library	060450006	2000	46	36	33	32	15	17	61	100
North Coast	Mendocino	Ukiah-County Library	060450006	1999	62	51	37	36			57	92
North Coast	Mendocino	Willits-Firehouse	060452001	1998	47	37	35	32	15	17	61	98
North Coast	Mendocino	Willits-Firehouse	060452001	2000	48	42	34	31	15	17	61	100
North Coast	Mendocino	Willits-Firehouse	060452001	1999	62	52	41	37			56	90
North Coast	Sonoma	Cloverdale	060970001	2000	44	34	34	33	10	12	58	98
North Coast	Sonoma	Cloverdale	060970001	1998	29	26	26	24	11	12	65	100
North Coast	Sonoma	Cloverdale	060970001	1999	71	42	33	32			56	87
North Coast	Sonoma	Guerneville-Church and 1st	060973002	1998	31	31	30	30	15	16	61	96
North Coast	Sonoma	Guerneville-Church and 1st	060973002	2000	33	30	30	29			59	98
North Coast	Sonoma	Guerneville-Church and 1st	060973002	1999	61	50	39	30			58	95
North Coast	Sonoma	Healdsburg-133 Matheson Street	060970002	1999	69	64	58	43	16	18	60	99
North Coast	Sonoma	Healdsburg-133 Matheson Street	060970002	1998	32	27	27	27			60	98
North Coast	Sonoma	Healdsburg-133 Matheson Street	060970002	2000	41	33	27	26			57	98
North Coast	Trinity	Weaverville-Courthouse	061050002	1998	46	39	39	36	16	19	58	85
North Coast	Trinity	Weaverville-Courthouse	061050002	2000	51	48	47	44	16	19	59	87
North Coast	Trinity	Weaverville-Courthouse	061050002	1999	100	78	74	62	21	25	61	86
Northeast Plateau	Lassen	Susanville-Russel	060351001	1998	52	52	46	44			14	33
Northeast Plateau	Lassen	Susanville-Russel	060351001	2000	80	65	64	61			33	49
Northeast Plateau	Lassen	Susanville-Russel	060351001	1999	100	96	87	65			53	82
Northeast Plateau	Modoc	Alturas-W 4th Street	060490001	2000	79	59	53	47	18	23	59	91
Northeast Plateau	Modoc	Alturas-W 4th Street	060490001	1999	94	73	68	60	22	26	58	98
Northeast Plateau	Modoc	Alturas-W 4th Street	060490001	1998	62	60	50	44			43	61
Northeast Plateau	Siskiyou	Lava Beds Natl Monument	060930005	1998	48	18	15	14			54	87
Northeast Plateau	Siskiyou	Lava Beds Natl Monument	060930005	2000	27	16	16	14			55	82
Northeast Plateau	Siskiyou	Lava Beds Natl Monument	060930005	1999	31	28	27	24			53	86
Northeast Plateau	Siskiyou	Mt Shasta-N Old Stage Road	060930004	1999	56	47	42	39	14	18	59	98
Northeast Plateau	Siskiyou	Mt Shasta-N Old Stage Road	060930004	1998	43	26	26	24			58	96
Northeast Plateau	Siskiyou	Mt Shasta-N Old Stage Road	060930004	2000	53	31	30	29			55	85
Northeast Plateau	Siskiyou	Yreka-Foothill Drive	060932001	1999	39	37	34	31	16	17	60	100
Northeast Plateau	Siskiyou	Yreka-Foothill Drive	060932001	1998	66	30	29	29			51	82
Northeast Plateau	Siskiyou	Yreka-Foothill Drive	060932001	2000	34	33	33	31			55	90
Sacramento Valley	Butte	Chico-Manzanita Avenue	060070002	1998	68	56	54	51	19	22	60	99
Sacramento Valley	Butte	Chico-Manzanita Avenue	060070002	2000	81	77	67	58	25	28	71	95

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
Sacramento Valley	Butte	Chico-Manzanita Avenue	060070002	1999	95	81	75	65	26	30	60	100
Sacramento Valley	Colusa	Colusa-Sunrise Blvd	060111002	1998	58	48	46	45	16	19	59	97
Sacramento Valley	Colusa	Colusa-Sunrise Blvd	060111002	2000	55	48	45	45			60	73
Sacramento Valley	Colusa	Colusa-Sunrise Blvd	060111002	1999	171	89	82	78			55	88
Sacramento Valley	Glenn	Willows-E Laurel Street	060210002	1998	53	52	46	44	17	20	56	95
Sacramento Valley	Glenn	Willows-E Laurel Street	060210002	2000	65	49	48	45	19	22	61	87
Sacramento Valley	Glenn	Willows-E Laurel Street	060210002	1999	88	82	77	66			58	98
Sacramento Valley	Placer	Rocklin-Rocklin Road	060613001	1998	70	47	45	43	17	19	59	96
Sacramento Valley	Placer	Rocklin-Rocklin Road	060613001	2000	46	41	39	35	20	21	73	100
Sacramento Valley	Placer	Rocklin-Rocklin Road	060613001	1999	75	72	70	53	21	25	60	100
Sacramento Valley	Placer	Roseville-N Sunrise Blvd	060610006	1998	67	62	51	45	19	22	61	100
Sacramento Valley	Placer	Roseville-N Sunrise Blvd	060610006	2000	58	50	49	44	22	24	71	100
Sacramento Valley	Placer	Roseville-N Sunrise Blvd	060610006	1999	89	83	76	57	22	26	60	100
Sacramento Valley	Sacramento	North Highlands-Blackfoot Way	060670002	1998	73	60	50	44	19	22	61	98
Sacramento Valley	Sacramento	North Highlands-Blackfoot Way	060670002	2000	82	82	45	42	20	23	59	87
Sacramento Valley	Sacramento	North Highlands-Blackfoot Way	060670002	1999	73	55	53	52			56	93
Sacramento Valley	Sacramento	Sacramento-3801 Airport Road	060670013	1999	70	63	56	52	18	22	58	86
Sacramento Valley	Sacramento	Sacramento-3801 Airport Road	060670013	2000	73	64	43	40			52	74
Sacramento Valley	Sacramento	Sacramento-3801 Airport Road	060670013	1998	93	75	57	54			35	74
Sacramento Valley	Sacramento	Sacramento-Branch Center Road	060670283	1998	81	73	72	58	22	27	59	94
Sacramento Valley	Sacramento	Sacramento-Branch Center Road	060670283	2000	56	54	49	47			59	93
Sacramento Valley	Sacramento	Sacramento-Branch Center Road	060670283	1999	86	80	78	63			54	94
Sacramento Valley	Sacramento	Sacramento-Del Paso Manor	060670006	2000	58	55	50	46	18	21	61	92
Sacramento Valley	Sacramento	Sacramento-Del Paso Manor	060670006	1999	141	75	68	62	22	27	58	81
Sacramento Valley	Sacramento	Sacramento-Del Paso Manor	060670006	1998	104	83	62	49			59	90
Sacramento Valley	Sacramento	Sacramento-Health Dept Stockton Blvd	060674001	1998	79	66	55	55	20	24	60	98
Sacramento Valley	Sacramento	Sacramento-Health Dept Stockton Blvd	060674001	2000	86	62	48	47			50	67
Sacramento Valley	Sacramento	Sacramento-Health Dept Stockton Blvd	060674001	1999	88	62	56	46			56	83
Sacramento Valley	Sacramento	Sacramento-T Street	060670010	1998	75	55	55	50	20	23	61	100
Sacramento Valley	Sacramento	Sacramento-T Street	060670010	2000	64	59	58	57	23	25	70	99
Sacramento Valley	Sacramento	Sacramento-T Street	060670010	1999	99	98	84	71	24	29	60	100
Sacramento Valley	Shasta	Anderson-North Street	060890007	1998	61	54	52	50	21	23	60	97
Sacramento Valley	Shasta	Anderson-North Street	060890007	2000	49	47	42	40	22	24	61	96
Sacramento Valley	Shasta	Anderson-North Street	060890007	1999	81	47	40	40			34	25
Sacramento Valley	Shasta	Redding-Health Dept Roof	060890004	2000	49	38	37	36	17	19	60	97
Sacramento Valley	Shasta	Redding-Health Dept Roof	060890004	1998	50	48	37	37			57	98
Sacramento Valley	Shasta	Redding-Health Dept Roof	060890004	1999	77	75	68	50			54	90
Sacramento Valley	Solano	Vacaville-Merchant Street	060953001	1998	56	46	44	37	15	17	59	92
Sacramento Valley	Solano	Vacaville-Merchant Street	060953001	2000	47	44	42	42	16	18	61	100
Sacramento Valley	Solano	Vacaville-Merchant Street	060953001	1999	66	62	59	44	17	20	59	98
Sacramento Valley	Sutter	Yuba City-Almond Street	061010003	1998	60	54	53	51	20	24	60	99
Sacramento Valley	Sutter	Yuba City-Almond Street	061010003	1999	150	106	99	99	30	38	57	92
Sacramento Valley	Sutter	Yuba City-Almond Street	061010003	2000	70	66	62	52			65	88
Sacramento Valley	Tehama	Red Bluff-Riverside Drive	061030002	2000	49	44	43	41			59	92
Sacramento Valley	Tehama	Red Bluff-Riverside Drive	061030002	1998	119	67	66	65			50	77
Sacramento Valley	Tehama	Red Bluff-Riverside Drive	061030002	1999	98	75	73	68			44	80
Sacramento Valley	Yolo	West Sacramento-15th Street	061132001	1998	63	56	48	47	19	22	59	95
Sacramento Valley	Yolo	West Sacramento-15th Street	061132001	1999	126	109	78	78	26	31	59	99
Sacramento Valley	Yolo	West Sacramento-15th Street	061132001	2000	79	66	62	52			58	96
Sacramento Valley	Yolo	Woodland-Gibson Road	061131003	2000	63	54	50	48	20	23	60	96
Sacramento Valley	Yolo	Woodland-Gibson Road	061131003	1999	179	144	122	93	23	32	59	97

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
Sacramento Valley	Yolo	Woodland-Gibson Road	061131003	1998	69	53	45	34			12	25
Sacramento Valley	Yolo	Woodland-Sutter Street	061130005	1998	130	92	73	67	23	29	61	100
Sacramento Valley	Yolo	Woodland-Sutter Street	061130005	1999	56	28	15	8			5	3
Salton Sea	Imperial	Brawley-Main Street	060250003	1998	81	73	72	71	36	38	56	91
Salton Sea	Imperial	Brawley-Main Street	060250003	1999	89	75	72	72	39	42	60	92
Salton Sea	Imperial	Brawley-Main Street	060250003	2000	204	111	110	94	46	51	60	92
Salton Sea	Imperial	Calexico-Ethel Street	060250005	1998	160	143	126	126	59	66	58	100
Salton Sea	Imperial	Calexico-Ethel Street	060250005	1999	181	162	137	131	66	72	55	94
Salton Sea	Imperial	Calexico-Ethel Street	060250005	2000	268	252	197	193	73	85	58	100
Salton Sea	Imperial	Calexico-Grant Street	060250004	1998	176	159	144	138	52	64	61	92
Salton Sea	Imperial	Calexico-Grant Street	060250004	1999	227	174	170	165	66	78	58	97
Salton Sea	Imperial	Calexico-Grant Street	060250004	2000	252	236	213	181			61	90
Salton Sea	Imperial	El Centro-9th Street	060251003	1998	90	84	76	67	30	34	60	92
Salton Sea	Imperial	El Centro-9th Street	060251003	1999	92	76	74	73	38	42	60	93
Salton Sea	Imperial	El Centro-9th Street	060251003	2000	180	134	126	89			56	95
Salton Sea	Imperial	Niland-English Road	060254004	1999	58	54	53	52	31	34	59	99
Salton Sea	Imperial	Niland-English Road	060254004	1998	75	63	62	52			59	83
Salton Sea	Imperial	Niland-English Road	060254004	2000	214	204	116	115			58	94
Salton Sea	Imperial	Westmorland-W 1st Street	060254003	1998	81	70	69	59	28	32	51	99
Salton Sea	Imperial	Westmorland-W 1st Street	060254003	1999	130	94	84	76	40	44	59	100
Salton Sea	Imperial	Westmorland-W 1st Street	060254003	2000	250	168	114	108	45	54	59	94
Salton Sea	Imperial	Winterhaven-2nd Avenue	060254002	1998	96	48	25	12			61	8
Salton Sea	Riverside	Indio-Jackson Street	060652002	1998	158	114	105	96	45	48	60	100
Salton Sea	Riverside	Indio-Jackson Street	060652002	2000	201	190	183	114	50	55	4	100
Salton Sea	Riverside	Indio-Jackson Street	060652002	1999	119	94	88	76			60	96
Salton Sea	Riverside	Palm Springs-Fire Station	060655001	1998	72	61	53	45	24	26	81	91
Salton Sea	Riverside	Palm Springs-Fire Station	060655001	1999	104	61	51	43	26	29	56	94
Salton Sea	Riverside	Palm Springs-Fire Station	060655001	2000	44	40	40	39			106	90
San Diego	San Diego	Chula Vista	060730001	1998	39	38	37	36	21	22	58	96
San Diego	San Diego	Chula Vista	060730001	2000	52	45	43	42			56	89
San Diego	San Diego	Chula Vista	060730001	1999	59	56	50	50			58	86
San Diego	San Diego	El Cajon-Redwood Avenue	060730003	1998	54	46	45	44	25	26	59	93
San Diego	San Diego	El Cajon-Redwood Avenue	060730003	2000	69	51	49	46	30	31	54	99
San Diego	San Diego	El Cajon-Redwood Avenue	060730003	1999	60	57	55	53	32	34	49	98
San Diego	San Diego	Escondido-E Valley Parkway	060731002	1999	52	50	48	48	29	30	59	94
San Diego	San Diego	Escondido-E Valley Parkway	060731002	1998	51	40	39	39			59	61
San Diego	San Diego	Escondido-E Valley Parkway	060731002	2000	65	56	49	44			61	93
San Diego	San Diego	Oceanside-Mission Avenue	060730005	1998	36	34	34	34			47	75
San Diego	San Diego	Otay Mesa-Paseo International	060732007	1998	89	88	88	80	39	43	60	96
San Diego	San Diego	Otay Mesa-Paseo International	060732007	1999	121	112	107	107	48	52	59	92
San Diego	San Diego	Otay Mesa-Paseo International	060732007	2000	139	86	73	71			45	98
San Diego	San Diego	San Diego-12th Avenue	060731007	1999	69	64	56	54	31	33	55	96
San Diego	San Diego	San Diego-12th Avenue	060731007	2000	65	61	53	53	32	34	61	96
San Diego	San Diego	San Diego-12th Avenue	060731007	1998	48	45	43	42			61	91
San Diego	San Diego	San Diego-Logan Avenue	060731009	2000	61	57	57	53			59	55
San Diego	San Diego	San Diego-Logan Avenue	060731009	1999	61	54	50	50			56	30
San Diego	San Diego	San Diego-Overland Avenue	060730006	2000	55	52	51	43	25	27	39	97
San Diego	San Diego	San Diego-Overland Avenue	060730006	1998	36	36	36	35			60	89
San Diego	San Diego	San Diego-Overland Avenue	060730006	1999	56	55	46	44			14	89
San Francisco Bay Area	Alameda	Fremont-Chapel Way	060011001	2000	58	50	48	42	19	21	59	100
San Francisco Bay Area	Alameda	Fremont-Chapel Way	060011001	1998	63	45	41	37	20	22	56	100

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
San Francisco Bay Area	Alameda	Fremont-Chapel Way	060011001	1999	88	52	50	49	22	24	64	100
San Francisco Bay Area	Alameda	Livermore-793 Rincon Avenue	060010007	2000	71	63	43	42	19	21	60	100
San Francisco Bay Area	Alameda	Livermore-793 Rincon Avenue	060010007	1999	28	27	24				61	7
San Francisco Bay Area	Alameda	Livermore-Old 1st Street	060010003	2000	68	53	43	41	19	21	62	100
San Francisco Bay Area	Alameda	Livermore-Old 1st Street	060010003	1998	62	53	45	42	19	21	61	100
San Francisco Bay Area	Alameda	Livermore-Old 1st Street	060010003	1999	87	65	65	50	23	26	3	100
San Francisco Bay Area	Alameda	San Leandro-County Hospital	060010006	1998	32	25	25	20			61	41
San Francisco Bay Area	Contra Costa	Bethel Island Road	060131002	2000	62	49	48	48	17	20	30	97
San Francisco Bay Area	Contra Costa	Bethel Island Road	060131002	1998	67	59	48	48	17	20	60	100
San Francisco Bay Area	Contra Costa	Bethel Island Road	060131002	1999	101	88	63	60	21	25	61	98
San Francisco Bay Area	Contra Costa	Concord-2975 Treat Blvd	060130002	2000	54	48	39	36	16	18	61	100
San Francisco Bay Area	Contra Costa	Concord-2975 Treat Blvd	060130002	1998	66	38	38	37	16	18	61	100
San Francisco Bay Area	Contra Costa	Concord-2975 Treat Blvd	060130002	1999	64	62	60	47	18	21	60	100
San Francisco Bay Area	Contra Costa	Pittsburg-10th Street	060133001	2000	56	50	41	37	14	16	60	100
San Francisco Bay Area	Contra Costa	Pittsburg-10th Street	060133001	1999	72	70	44	36			61	52
San Francisco Bay Area	Contra Costa	San Pablo-El Portal	060131003	1998	32	30	29	27			61	35
San Francisco Bay Area	Marin	San Rafael	060410001	1998	52	40	36	35	19	20	25	100
San Francisco Bay Area	Marin	San Rafael	060410001	1999	76	64	46	38	19	22	61	100
San Francisco Bay Area	Marin	San Rafael	060410001	2000	40	39	36	34			30	88
San Francisco Bay Area	Napa	Napa-Jefferson Avenue	060550003	2000	45	43	41	34	15	16	61	99
San Francisco Bay Area	Napa	Napa-Jefferson Avenue	060550003	1998	60	32	29	28	16	17	61	96
San Francisco Bay Area	Napa	Napa-Jefferson Avenue	060550003	1999	66	52	39	35	16	19	60	97
San Francisco Bay Area	San Francisco	San Francisco-Arkansas Street	060750005	1998	52	46	44	44	20	22	60	97
San Francisco Bay Area	San Francisco	San Francisco-Arkansas Street	060750005	2000	63	53	46	44	22	24	61	99
San Francisco Bay Area	San Francisco	San Francisco-Arkansas Street	060750005	1999	78	69	68	60	23	26	60	100
San Francisco Bay Area	San Mateo	Redwood City	060811001	2000	53	50	48	42	19	21	61	98
San Francisco Bay Area	San Mateo	Redwood City	060811001	1998	49	45	40	40	21	22	61	100
San Francisco Bay Area	San Mateo	Redwood City	060811001	1999	85	68	58	50	22	25	60	98
San Francisco Bay Area	Santa Clara	San Jose-4th Street	060850004	1998	92	54	52	48	23	25	61	96
San Francisco Bay Area	Santa Clara	San Jose-4th Street	060850004	2000	76	68	64	61	24	27	61	100
San Francisco Bay Area	Santa Clara	San Jose-4th Street	060850004	1999	114	64	59	55	25	29	60	100
San Francisco Bay Area	Santa Clara	San Jose-935 Piedmont Road	060852005	1998	54	30	29	23			60	32
San Francisco Bay Area	Santa Clara	San Jose-Moorpark Avenue	060853001	1998	42	27	24	23			60	38
San Francisco Bay Area	Santa Clara	San Jose-Tully Road	060852003	2000	68	54	50	47	18	21	30	95
San Francisco Bay Area	Santa Clara	San Jose-Tully Road	060852003	1998	88	43	41	37	20	22	61	100
San Francisco Bay Area	Santa Clara	San Jose-Tully Road	060852003	1999	96	93	60	58	22	25	30	90
San Francisco Bay Area	Solano	Vallejo-304 Tuolumne Street	060950004	2000	53	46	36	28	13	15	60	100
San Francisco Bay Area	Solano	Vallejo-304 Tuolumne Street	060950004	1998	71	41	40	40	15	17	61	100
San Francisco Bay Area	Solano	Vallejo-304 Tuolumne Street	060950004	1999	84	62	53	46			60	94
San Francisco Bay Area	Sonoma	Santa Rosa-5th Street	060970003	2000	46	40	36	35	16	18	61	94
San Francisco Bay Area	Sonoma	Santa Rosa-5th Street	060970003	1998	53	38	31	29			61	94
San Francisco Bay Area	Sonoma	Santa Rosa-5th Street	060970003	1999	54	45	38	38			60	94
San Joaquin Valley	Fresno	Clovis-N Villa Avenue	060195001	1998	113	94	78	64	27	33	61	93
San Joaquin Valley	Fresno	Clovis-N Villa Avenue	060195001	1999	151	113	108	97	38	47	59	95
San Joaquin Valley	Fresno	Clovis-N Villa Avenue	060195001	2000	114	101	101	99			60	84
San Joaquin Valley	Fresno	Fresno-1st Street	060190008	1998	141	104	75	65	27	34	59	97
San Joaquin Valley	Fresno	Fresno-1st Street	060190008	2000	138	114	113	110	33	40	55	100
San Joaquin Valley	Fresno	Fresno-1st Street	060190008	1999	154	124	124	121	36	45	58	100
San Joaquin Valley	Fresno	Fresno-Drummond Street	060190007	1998	132	117	94	93	31	39	60	93
San Joaquin Valley	Fresno	Fresno-Drummond Street	060190007	2000	130	122	101	87			61	87
San Joaquin Valley	Fresno	Fresno-Drummond Street	060190007	1999	162	130	119	116			60	88

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
San Joaquin Valley	Kern	Bakersfield-5558 California Avenue	060290014	1998	148	112	112	93	32	38	58	99
San Joaquin Valley	Kern	Bakersfield-5558 California Avenue	060290014	2000	140	133	116	103	40	46	56	100
San Joaquin Valley	Kern	Bakersfield-5558 California Avenue	060290014	1999	143	138	114	111	40	47	53	99
San Joaquin Valley	Kern	Bakersfield-Golden State Highway	060290010	2000	145	143	121	119	45	53	115	100
San Joaquin Valley	Kern	Bakersfield-Golden State Highway	060290010	1999	183	141	135	132	50	60	115	100
San Joaquin Valley	Kern	Bakersfield-Golden State Highway	060290010	1998	159	135	112	103			116	83
San Joaquin Valley	Kern	Oildale-3311 Manor Street	060290232	1998	103	88	83	71	31	37	40	93
San Joaquin Valley	Kern	Oildale-3311 Manor Street	060290232	2000	122	102	82	76	35	41	61	87
San Joaquin Valley	Kern	Oildale-3311 Manor Street	060290232	1999	156	135	133	116	41	51	59	90
San Joaquin Valley	Kern	Taft College	060292004	1999	101	86	74	70	29	34	56	92
San Joaquin Valley	Kern	Taft College	060292004	2000	99	92	92	77	29	34	63	94
San Joaquin Valley	Kern	Taft College	060292004	1998	84	81	79	73			60	95
San Joaquin Valley	Kings	Corcoran-Patterson Avenue	060310004	2000	128	122	119	113	38	47	65	95
San Joaquin Valley	Kings	Corcoran-Patterson Avenue	060310004	1999	174	174	146	145	41	53	64	100
San Joaquin Valley	Kings	Corcoran-Patterson Avenue	060310004	1998	128	116	108	102			54	98
San Joaquin Valley	Kings	Corcoran-Van Dorsten Avenue	060310003	1998	78	64	59	56			65	35
San Joaquin Valley	Kings	Hanford-S Irwin Street	060311004	1998	146	109	86	75			117	83
San Joaquin Valley	Kings	Hanford-S Irwin Street	060311004	2000	119	116	101	98			46	79
San Joaquin Valley	Kings	Hanford-S Irwin Street	060311004	1999	143	140	138	134			97	83
San Joaquin Valley	Merced	Merced-2334 M Street	060472510	2000	104	89	86	71	30	35	54	95
San Joaquin Valley	Merced	Merced-2334 M Street	060472510	1999	134	114	113	110			52	75
San Joaquin Valley	San Joaquin	Stockton-Hazelton Street	060771002	1998	106	95	89	76	24	29	51	91
San Joaquin Valley	San Joaquin	Stockton-Hazelton Street	060771002	2000	91	86	64	62	29	32	60	95
San Joaquin Valley	San Joaquin	Stockton-Hazelton Street	060771002	1999	150	123	119	84	30	36	44	100
San Joaquin Valley	San Joaquin	Stockton-Wagner-Holt School	060773010	1998	99	80	75	61	21	26	58	94
San Joaquin Valley	San Joaquin	Stockton-Wagner-Holt School	060773010	2000	104	76	75	72	25	29	61	95
San Joaquin Valley	San Joaquin	Stockton-Wagner-Holt School	060773010	1999	118	90	63	52			60	52
San Joaquin Valley	Stanislaus	Modesto-14th Street	060990005	2000	112	106	100	91	29	35	59	100
San Joaquin Valley	Stanislaus	Modesto-14th Street	060990005	1999	132	124	124	119	34	41	41	100
San Joaquin Valley	Stanislaus	Modesto-14th Street	060990005	1998	125	109	90	80			58	69
San Joaquin Valley	Stanislaus	Modesto-I Street	060990002	1998	61	57	54	45			40	24
San Joaquin Valley	Stanislaus	Turlock-S Minaret Street	060990006	1998	108	105	87	72	25	31	119	100
San Joaquin Valley	Stanislaus	Turlock-S Minaret Street	060990006	2000	104	95	83	68	30	34	72	93
San Joaquin Valley	Stanislaus	Turlock-S Minaret Street	060990006	1999	157	129	114	109			120	78
San Joaquin Valley	Tulare	Visalia-N Church Street	061072002	1998	160	123	101	94	32	40	61	99
San Joaquin Valley	Tulare	Visalia-N Church Street	061072002	2000	130	127	124	111	45	53	60	100
San Joaquin Valley	Tulare	Visalia-N Church Street	061072002	1999	152	137	125	116	46	55	54	100
South Central Coast	San Luis Obispo	Arroyo Grande-Ralcoa Way	060791005	1999	90	82	58	56	22	27	61	96
South Central Coast	San Luis Obispo	Arroyo Grande-Ralcoa Way	060791005	1998	70	67	60	60			62	76
South Central Coast	San Luis Obispo	Arroyo Grande-Ralcoa Way	060791005	2000	110	100	97	88			61	90
South Central Coast	San Luis Obispo	Atascadero-Lewis Avenue	060798001	1999	43	43	39	39	16	19	59	94
South Central Coast	San Luis Obispo	Atascadero-Lewis Avenue	060798001	1998	47	38	38	28			51	89
South Central Coast	San Luis Obispo	Atascadero-Lewis Avenue	060798001	2000	67	52	43	39			55	91
South Central Coast	San Luis Obispo	Morro Bay	060793001	1998	33	24	24	24			53	83
South Central Coast	San Luis Obispo	Morro Bay	060793001	1999	39	37	37	31			63	93
South Central Coast	San Luis Obispo	Morro Bay	060793001	2000	47	41	40	39			56	76
South Central Coast	San Luis Obispo	Nipomo-Guadalupe Road	060792004	1999	72	53	52	50	19	22	61	100
South Central Coast	San Luis Obispo	Nipomo-Guadalupe Road	060792004	1998	65	57	54	50	19	22	54	100
South Central Coast	San Luis Obispo	Nipomo-Guadalupe Road	060792004	2000	107	102	98	80			48	97
South Central Coast	San Luis Obispo	Nipomo-Regional Park	060794002	2000	113	48	42	42	18	22	56	95
South Central Coast	San Luis Obispo	Nipomo-Regional Park	060794002	1998	27	25	24	22			61	18

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
South Central Coast	San Luis Obispo	Nipomo-Regional Park	060794002	1999	41	39	33	30			60	92
South Central Coast	San Luis Obispo	Paso Robles-Santa Fe Avenue	060790005	1998	57	47	41	34	16	18	10	95
South Central Coast	San Luis Obispo	Paso Robles-Santa Fe Avenue	060790005	2000	74	58	46	45	18	21	58	91
South Central Coast	San Luis Obispo	Paso Robles-Santa Fe Avenue	060790005	1999	56	44	44	41			59	94
South Central Coast	San Luis Obispo	San Luis Obispo-Marsh Street	060792002	1998	32	27	24	23	15	15	59	96
South Central Coast	San Luis Obispo	San Luis Obispo-Marsh Street	060792002	2000	44	39	34	33	18	19	57	96
South Central Coast	San Luis Obispo	San Luis Obispo-Marsh Street	060792002	1999	42	37	35	30			55	92
South Central Coast	Santa Barbara	El Capitan Beach	060830008	2000	46	45	37	36	19	21	59	100
South Central Coast	Santa Barbara	El Capitan Beach	060830008	1999	51	49	42	33	20	22	55	100
South Central Coast	Santa Barbara	El Capitan Beach	060830008	1998	50	42	38	34			58	94
South Central Coast	Santa Barbara	Exxon Site 10-UCSB West Campus	060831020	1998	33	32	30	28			58	46
South Central Coast	Santa Barbara	Gaviota-East	060831016	1998	29	24	24	21			60	5
South Central Coast	Santa Barbara	Gaviota-GTC Site C	060831019	1998	20	18	17	16			61	12
South Central Coast	Santa Barbara	Gaviota-West	060831015	1998	28	25	24	22			28	2
South Central Coast	Santa Barbara	Las Flores Canyon #1	060831025	1998	44	35	34	33	13	16	14	99
South Central Coast	Santa Barbara	Las Flores Canyon #1	060831025	2000	49	36	35	34	16	18	15	96
South Central Coast	Santa Barbara	Las Flores Canyon #1	060831025	1999	40	33	30	29			21	97
South Central Coast	Santa Barbara	Las Flores Canyon #2	060831026	1998	43	35	34	34	13	16	59	98
South Central Coast	Santa Barbara	Las Flores Canyon #2	060831026	1999	27	21	9	9			55	12
South Central Coast	Santa Barbara	Lompoc-S H Street	060832004	1998	45	35	31	29	17	18	59	100
South Central Coast	Santa Barbara	Lompoc-S H Street	060832004	1999	41	40	34	33	17	18	60	100
South Central Coast	Santa Barbara	Lompoc-S H Street	060832004	2000	49	48	45	43	20	22	5	98
South Central Coast	Santa Barbara	Point Conception-Lighthouse	060831012	1998	30	29	29	28			61	10
South Central Coast	Santa Barbara	Santa Barbara-W Carillo Street	060830010	1998	62	48	46	39	24	25	60	94
South Central Coast	Santa Barbara	Santa Barbara-W Carillo Street	060830010	1999	51	50	41	41	27	29	60	98
South Central Coast	Santa Barbara	Santa Barbara-W Carillo Street	060830010	2000	45	45	43	43			14	62
South Central Coast	Santa Barbara	Santa Maria-906 S Broadway	060831008	2000	53	53	50	45	24	26	59	100
South Central Coast	Santa Barbara	Santa Maria-906 S Broadway	060831008	1999	44	44	35	34			60	75
South Central Coast	Santa Barbara	Santa Maria-Library	060834001	1998	73	53	52	46	20	23	46	97
South Central Coast	Santa Barbara	Santa Maria-Library	060834001	1999	32	29	28	25			35	8
South Central Coast	Santa Barbara	Vandenberg Air Force Base-STS Power	060834003	1999	45	40	37	29	12	15	58	100
South Central Coast	Santa Barbara	Vandenberg Air Force Base-STS Power	060834003	1998	31	30	30	29	15	17	61	100
South Central Coast	Santa Barbara	Vandenberg Air Force Base-STS Power	060834003	2000	48	42	40	37	16	19	15	95
South Central Coast	Ventura	El Rio-Rio Mesa School #2	061113001	1998	70	50	48	45	19	23	61	97
South Central Coast	Ventura	El Rio-Rio Mesa School #2	061113001	2000	52	46	45	42	25	27	59	100
South Central Coast	Ventura	El Rio-Rio Mesa School #2	061113001	1999	51	48	45	44	26	28	60	95
South Central Coast	Ventura	Ojai-Ojai Avenue	061111004	1998	110	52	44	41	18	21	59	97
South Central Coast	Ventura	Ojai-Ojai Avenue	061111004	2000	46	42	40	39	23	25	61	100
South Central Coast	Ventura	Ojai-Ojai Avenue	061111004	1999	54	53	50	48	26	29	56	98
South Central Coast	Ventura	Piru-2 miles SW	061110004	1998	51	45	44	44	19	23	59	96
South Central Coast	Ventura	Piru-2 miles SW	061110004	1999	56	52	48	48	25	28	60	98
South Central Coast	Ventura	Piru-2 miles SW	061110004	2000	78	74	51	49			61	91
South Central Coast	Ventura	Piru-3301 Pacific Avenue	061110009	2000	24	21	19	17			59	6
South Central Coast	Ventura	Simi Valley-Cochran Street	061112002	1998	48	48	44	44	19	23	58	97
South Central Coast	Ventura	Simi Valley-Cochran Street	061112002	2000	71	68	52	48	25	29	6	92
South Central Coast	Ventura	Simi Valley-Cochran Street	061112002	1999	67	62	57	56			52	94
South Central Coast	Ventura	Thousand Oaks-Moorpark Road	061110007	1998	50	49	48	47	21	24	60	91
South Central Coast	Ventura	Thousand Oaks-Moorpark Road	061110007	2000	100	80	78	56	26	31	57	96
South Central Coast	Ventura	Thousand Oaks-Moorpark Road	061110007	1999	84	56	54	52	28	31	55	96
South Coast	Los Angeles	Azusa	060370002	1999	103	101	96	93	52	56	56	100
South Coast	Los Angeles	Azusa	060370002	1998	87	78	77	74			59	93

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
South Coast	Los Angeles	Azusa	060370002	2000	94	93	77	74			59	95
South Coast	Los Angeles	Burbank-W Palm Avenue	060371002	1998	75	65	56	56	33	36	57	92
South Coast	Los Angeles	Burbank-W Palm Avenue	060371002	1999	82	71	71	69	41	44	60	100
South Coast	Los Angeles	Burbank-W Palm Avenue	060371002	2000	74	70	62	60			57	98
South Coast	Los Angeles	Hawthorne	060375001	1998	66	62	54	53	30	32	59	95
South Coast	Los Angeles	Hawthorne	060375001	1999	69	63	62	56	33	35	60	98
South Coast	Los Angeles	Hawthorne	060375001	2000	74	71	60	59	33	36	60	96
South Coast	Los Angeles	Los Angeles-North Main Street	060371103	1998	80	71	68	68	34	38	59	92
South Coast	Los Angeles	Los Angeles-North Main Street	060371103	2000	80	79	71	61	37	40	57	98
South Coast	Los Angeles	Los Angeles-North Main Street	060371103	1999	88	87	72	70	42	45	60	100
South Coast	Los Angeles	North Long Beach	060374002	1998	69	60	57	55	29	32	60	92
South Coast	Los Angeles	North Long Beach	060374002	1999	79	77	62	59	36	39	60	99
South Coast	Los Angeles	North Long Beach	060374002	2000	105	92	82	66			60	95
South Coast	Los Angeles	Santa Clarita-County Fire Station	060376002	2000	64	59	55	53	30	33	57	100
South Coast	Los Angeles	Santa Clarita-County Fire Station	060376002	1999	75	69	67	65	34	38	59	91
South Coast	Los Angeles	Santa Clarita-County Fire Station	060376002	1998	60	51	51	50			59	89
South Coast	Orange	Anaheim-Harbor Blvd	060590001	1998	81	65	62	55	33	36	55	100
South Coast	Orange	Anaheim-Harbor Blvd	060590001	2000	126	119	99	81	36	40	61	91
South Coast	Orange	Anaheim-Harbor Blvd	060590001	1999	122	112	93	89			56	77
South Coast	Orange	El Toro	060592001	1998	70	58	54	53	28	31	61	94
South Coast	Orange	El Toro	060592001	1999	111	73	68	53	34	37	39	100
South Coast	Orange	El Toro	060592001	2000	60	42	39	39			61	31
South Coast	Orange	Mission Viejo-26081 Via Pera	060592022	2000	98	55	45	43	26	28	60	98
South Coast	Orange	Mission Viejo-26081 Via Pera	060592022	1999	56	46	39	36			59	68
South Coast	Riverside	Banning Airport	060650012	2000	69	58	56	54	25	29	60	96
South Coast	Riverside	Banning Airport	060650012	1998	62	58	49	49			31	83
South Coast	Riverside	Banning Airport	060650012	1999	86	68	58	51			32	66
South Coast	Riverside	Banning-Allesandro	060650002	1999	47	41	39	38			34	1
South Coast	Riverside	Banning-Allesandro	060650002	1998	76	66	53	53			52	85
South Coast	Riverside	Norco-Norconian	060650003	1998	93	92	88	88			59	94
South Coast	Riverside	Norco-Norconian	060650003	2000	129	119	86	80			8	96
South Coast	Riverside	Norco-Norconian	060650003	1999	136	116	108	107			55	97
South Coast	Riverside	Perris	060656001	2000	87	75	75	73	37	41	58	95
South Coast	Riverside	Perris	060656001	1999	112	98	92	91	44	50	56	100
South Coast	Riverside	Perris	060656001	1998	98	81	76	66			57	85
South Coast	Riverside	Riverside-Rubidoux	060658001	2000	139	139	131	126	55	59	59	100
South Coast	Riverside	Riverside-Rubidoux	060658001	1999	153	134	119	118	65	72	60	100
South Coast	Riverside	Riverside-Rubidoux	060658001	1998	116	111	109	107			53	91
South Coast	San Bernardino	Crestline	060710005	1998	45	43	43	41	21	25	78	92
South Coast	San Bernardino	Crestline	060710005	2000	49	44	42	42			97	97
South Coast	San Bernardino	Crestline	060710005	1999	47	44	43	42			64	94
South Coast	San Bernardino	Fontana-Arrow Highway	060712002	1998	101	100	92	92	43	50	58	97
South Coast	San Bernardino	Fontana-Arrow Highway	060712002	2000	108	103	92	92	47	53	58	96
South Coast	San Bernardino	Fontana-Arrow Highway	060712002	1999	116	106	100	99	54	60	57	99
South Coast	San Bernardino	Ontario-1408 Francis Street	060710025	2000	124	93	89	85			60	94
South Coast	San Bernardino	Ontario-1408 Francis Street	060710025	1998	100	66	37	18			60	3
South Coast	San Bernardino	Ontario-1408 Francis Street	060710025	1999	183	127	126	116			59	90
South Coast	San Bernardino	Ontario-Airport	060716001	1998	92	92	92	90	40	47	4	94
South Coast	San Bernardino	Ontario-Airport	060716001	1999	112	97	93	92	50	55	55	95
South Coast	San Bernardino	Ontario-Airport	060716001	2000	59	58	36	26			58	7
South Coast	San Bernardino	Redlands-Dearborn	060714003	1998	97	88	84	83	34	40	59	91

Appendix 6-A
PM10 Air Quality Data

Basin Name	County Name	Site Name	Airs Site Id	Year	1st High	2nd High	3rd High	4th High	Annual Geo. Mean	Average of Quarters	Number of Obs.	High Season Coverage (%)
South Coast	San Bernardino	Redlands-Dearborn	060714003	2000	109	93	76	76	40	46	5	100
South Coast	San Bernardino	Redlands-Dearborn	060714003	1999	92	91	90	86	40	47	57	96
South Coast	San Bernardino	San Bernardino-4th Street	060719004	1998	114	102	95	94	39	46	60	96
South Coast	San Bernardino	San Bernardino-4th Street	060719004	1999	134	108	101	97	51	57	57	96
South Coast	San Bernardino	San Bernardino-4th Street	060719004	2000	108	108	88	78			61	99

Appendix 6

Supplementary Material for Chapter 6

Part B

PM2.5 Air Quality Data

Appendix 6-B
PM2.5 Air Quality Data

Basin Name	County Name	Site Name	AIRS Site Id	Year	1st High	2nd High	3rd High	4th High	Average of Quarters	Valid Qtrs	Number of Obs.
Great Basin Valleys	Inyo	Keeler-Cerro Gordo Road	060271003	1999	41	31	17	17			69
Great Basin Valleys	Inyo	Keeler-Cerro Gordo Road	060271003	2000	68	67	60	45			72
Great Basin Valleys	Mono	Mammoth Lakes-Gateway HC	60510001	2000	31	31	28	26			13
Lake County	Lake	Lakeport-Lakeport Blvd	060333001	1999	15	12	10	8			46
Lake County	Lake	Lakeport-Lakeport Blvd	060333001	2000	9	8	8	7			28
Lake Tahoe	El Dorado	South Lake Tahoe-Sandy Way	060170011	1999	21	21	19	19	8	4	59
Lake Tahoe	El Dorado	South Lake Tahoe-Sandy Way	060170011	2000	23	21	21	19	8	4	59
Mojave Desert	Kern	Mojave-923 Poole Street	060290011	1999	28	16	14	14			99
Mojave Desert	Kern	Mojave-923 Poole Street	060290011	2000	29	26	14	14			72
Mojave Desert	Kern	Ridgecrest-Las Flores Avenue	060290012	1999	23	18	17	15			47
Mojave Desert	Kern	Ridgecrest-Las Flores Avenue	060290012	2000	39	25	22	20	8	4	91
Mojave Desert	Los Angeles	Lancaster-W Pondera Street	060379002	1999	48	26	24	22	11	4	113
Mojave Desert	Los Angeles	Lancaster-W Pondera Street	060379002	2000	36	25	21	19	10	4	113
Mojave Desert	San Bernardino	Victorville-14306 Park Avenue	060710306	2000	31	29	23	23	12	4	115
Mojave Desert	San Bernardino	Victorville-Armagosa Road	060710014	1999	25	24	20	20	12	4	114
Mountain Counties	Calaveras	San Andreas-Gold Strike Road	060090001	1999	33	28	27	24	11	4	59
Mountain Counties	Calaveras	San Andreas-Gold Strike Road	060090001	2000	48	30	20	18	9	4	63
Mountain Counties	Nevada	Grass Valley-Litton Building	060570005	1999	31	31	18	18			52
Mountain Counties	Nevada	Grass Valley-Litton Building	060570005	2000	27	19	17	13			45
Mountain Counties	Nevada	Truckee-Fire Station	060571001	1999	50	32	27	24			46
Mountain Counties	Nevada	Truckee-Fire Station	060571001	2000	23	22	22	22	9	4	111
Mountain Counties	Plumas	Portola-161 Nevada Street	060631009	2000	46	44	43	41			67
Mountain Counties	Plumas	Portola-Commercial Street	060631008	1999	70	40	21	19			46
Mountain Counties	Plumas	Quincy-N Church Street	060631006	1999	92	84	72	67			73
Mountain Counties	Plumas	Quincy-N Church Street	060631006	2000	37	36	34	29			104
North Central Coast	Monterey	Salinas-High School	060531003	2000	26	22	22	20			73
North Central Coast	Monterey	Salinas-Natividad Road #2	060531002	1999	31	25	24	21			100
North Central Coast	Santa Cruz	Santa Cruz-2544 Soquel Avenue	060870007	1999	31	22	18	18			89
North Central Coast	Santa Cruz	Santa Cruz-2544 Soquel Avenue	060870007	2000	23	18	18	17			72
North Coast	Humboldt	Eureka-Health Dept 6th and I Street	060231002	1999	37	28	26	21	9	4	59
North Coast	Humboldt	Eureka-Health Dept 6th and I Street	060231002	2000	24	22	21	21	9	4	58
North Coast	Mendocino	Ukiah-County Library	060450006	1999	36	26	19	19	9	4	58
North Coast	Mendocino	Ukiah-County Library	060450006	2000	20	19	18	18			56
Northeast Plateau	Modoc	Alturas-W 4th Street	060490001	1999	40	27	21	17	8	4	56
Northeast Plateau	Modoc	Alturas-W 4th Street	060490001	2000	38	37	23	22	9	4	58
Sacramento Valley	Butte	Chico-Manzanita Avenue	060070002	1999	73	60	52	49	18	4	59
Sacramento Valley	Butte	Chico-Manzanita Avenue	060070002	2000	98	70	61	55	16	4	61
Sacramento Valley	Colusa	Colusa-Sunrise Blvd	060111002	1999	55	47	44	42			85
Sacramento Valley	Colusa	Colusa-Sunrise Blvd	060111002	2000	28	27	26	23	8	4	114
Sacramento Valley	Placer	Roseville-N Sunrise Blvd	060610006	1999	79	40	33	32	13	4	59
Sacramento Valley	Placer	Roseville-N Sunrise Blvd	060610006	2000	51	43	35	35	12	4	59
Sacramento Valley	Sacramento	Sacramento-Del Paso Manor	060670006	1999	70	68	63	59			66
Sacramento Valley	Sacramento	Sacramento-Health Dept Stockton Blvd	060674001	1999	86	80	71	71	16	4	158

Appendix 6-B
PM2.5 Air Quality Data

Basin Name	County Name	Site Name	AIRS Site Id	Year	1st High	2nd High	3rd High	4th High	Average of Quarters	Valid Qtrs	Number of Obs.
Sacramento Valley	Sacramento	Sacramento-Health Dept Stockton Blvd	060674001	2000	65	64	58	50			128
Sacramento Valley	Sacramento	Sacramento-T Street	060670010	1999	108	92	90	76	17	4	264
Sacramento Valley	Sacramento	Sacramento-T Street	060670010	2000	67	64	63	56	12	4	331
Sacramento Valley	Shasta	Redding-Health Dept Roof	060890004	1999	57	55	40	39	13	4	57
Sacramento Valley	Shasta	Redding-Health Dept Roof	060890004	2000	45	35	27	24			
Sacramento Valley	Sutter	Yuba City-Almond Street	061010003	1999	56	56	54	50			53
Sacramento Valley	Sutter	Yuba City-Almond Street	061010003	2000	44	38	27	24	11	4	61
Sacramento Valley	Yolo	Woodland-Gibson Road	061131003	1999	70	56	54	49	16	4	98
Sacramento Valley	Yolo	Woodland-Gibson Road	061131003	2000	46	40	38	34	10	4	116
Salton Sea	Imperial	Brawley-Main Street	060250003	1999	44	43	41	39			65
Salton Sea	Imperial	Brawley-Main Street	060250003	2000	55	42	38	38			75
Salton Sea	Imperial	Calexico-Ethel Street	060250005	1999	52	51	40	36	15	4	106
Salton Sea	Imperial	Calexico-Ethel Street	060250005	2000	84	64	56	56	17	4	113
Salton Sea	Imperial	El Centro-9th Street	060251003	1999	53	43	40	35			102
Salton Sea	Imperial	El Centro-9th Street	060251003	2000	56	39	28	21			86
Salton Sea	Riverside	Indio-Jackson Street	060652002	1999	30	30	26	25			83
Salton Sea	Riverside	Indio-Jackson Street	060652002	2000	29	27	26	25	11	4	115
Salton Sea	Riverside	Palm Springs-Fire Station	060655001	2000	28	23	23	22	10	4	120
San Diego	San Diego	Chula Vista	060730001	1999	47	32	30	29			101
San Diego	San Diego	Chula Vista	060730001	2000	40	38	32	32	13	4	100
San Diego	San Diego	El Cajon-Redwood Avenue	060730003	1999	47	38	38	37	16	4	321
San Diego	San Diego	El Cajon-Redwood Avenue	060730003	2000	66	50	49	48	16	4	290
San Diego	San Diego	Escondido-E Valley Parkway	060731002	1999	64	54	51	47	18	4	255
San Diego	San Diego	Escondido-E Valley Parkway	060731002	2000	66	55	51	49	16	4	305
San Diego	San Diego	San Diego-12th Avenue	060731007	1999	47	46	46	45	18	4	289
San Diego	San Diego	San Diego-12th Avenue	060731007	2000	66	62	55	51	16	4	267
San Diego	San Diego	San Diego-Overland Avenue	060730006	1999	43	32	32	26			81
San Diego	San Diego	San Diego-Overland Avenue	060730006	2000	48	32	25	23	12	4	101
San Francisco Bay Area	Alameda	Fremont-Chapel Way	060011001	1999	56	45	44	38		4	76
San Francisco Bay Area	Alameda	Fremont-Chapel Way	060011001	2000	45	42	36	33	11	4	89
San Francisco Bay Area	Alameda	Livermore-793 Rincon Avenue	060010007	1999	63	51	41	33			
San Francisco Bay Area	Alameda	Livermore-793 Rincon Avenue	060010007	2000	56	50	38	37	11	4	86
San Francisco Bay Area	Contra Costa	Concord-2975 Treat Blvd	060130002	1999	57	55	55	44			110
San Francisco Bay Area	Contra Costa	Concord-2975 Treat Blvd	060130002	2000	53	50	50	46	11	4	191
San Francisco Bay Area	San Francisco	San Francisco-Arkansas Street	060750005	1999	71	65	55	52			121
San Francisco Bay Area	San Francisco	San Francisco-Arkansas Street	060750005	2000	48	45	42	40			193
San Francisco Bay Area	San Mateo	Redwood City	060811001	1999	60	53	36	35			68
San Francisco Bay Area	San Mateo	Redwood City	060811001	2000	44	43	37	34	11	4	82
San Francisco Bay Area	Santa Clara	San Jose-4th Street	060850004	1999	70	69	65	63			117
San Francisco Bay Area	Santa Clara	San Jose-4th Street	060850004	2000	64	63	59	57	14	4	180
San Francisco Bay Area	Santa Clara	San Jose-Tully Road	060852003	1999	77	69	67	63			117
San Francisco Bay Area	Santa Clara	San Jose-Tully Road	060852003	2000	67	63	61	60			188
San Francisco Bay Area	Solano	Vallejo-304 Tuolumne Street	060950004	1999	91	52	49	49			62

Appendix 6-B
PM2.5 Air Quality Data

Basin Name	County Name	Site Name	AIRS Site Id	Year	1st High	2nd High	3rd High	4th High	Average of Quarters	Valid Qtrs	Number of Obs.
San Francisco Bay Area	Solano	Vallejo-304 Tuolumne Street	060950004	2000	60	60	44	40	12	4	90
San Francisco Bay Area	Sonoma	Santa Rosa-5th Street	060970003	1999	55	44	36	34	12	4	69
San Francisco Bay Area	Sonoma	Santa Rosa-5th Street	060970003	2000	40	40	37	37	10	4	90
San Joaquin Valley	Fresno	Clovis-N Villa Avenue	060195001	1999	98	83	59	56	20	4	82
San Joaquin Valley	Fresno	Clovis-N Villa Avenue	060195001	2000	75	72	64	50	16	4	70
San Joaquin Valley	Fresno	Fresno-1st Street	060190008	1999	136	134	132	131	28	4	275
San Joaquin Valley	Fresno	Fresno-1st Street	060190008	2000	160	128	112	108			194
San Joaquin Valley	Fresno	Fresno-Hamilton & Winery	060195025	2000	84	65	65	64	18	4	77
San Joaquin Valley	Kern	Bakersfield-410 E Planz Road	060290016	2000	91	87	76	73	20	4	102
San Joaquin Valley	Kern	Bakersfield-5558 California Avenue	060290014	1999	134	115	109	100	28	4	294
San Joaquin Valley	Kern	Bakersfield-5558 California Avenue	060290014	2000	113	111	110	107	22	4	329
San Joaquin Valley	Kern	Bakersfield-Golden State Highway	060290010	1999	134	98	95	92	28	4	84
San Joaquin Valley	Kern	Bakersfield-Golden State Highway	060290010	2000	108	102	94	86	23	4	91
San Joaquin Valley	Kings	Corcoran-Patterson Avenue	060310004	1999	53	44	39	34			
San Joaquin Valley	Kings	Corcoran-Patterson Avenue	060310004	2000	76	55	55	52	16	4	67
San Joaquin Valley	Merced	Merced-2334 M Street	060472510	1999	109	92	82	76			53
San Joaquin Valley	Merced	Merced-2334 M Street	060472510	2000	86	70	68	60	17	4	88
San Joaquin Valley	San Joaquin	Stockton-Hazelton Street	060771002	1999	101	86	79	78	20	4	117
San Joaquin Valley	San Joaquin	Stockton-Hazelton Street	060771002	2000	78	63	55	50	15	4	123
San Joaquin Valley	Stanislaus	Modesto-14th Street	060990005	1999	108	104	100	95	25	4	117
San Joaquin Valley	Stanislaus	Modesto-14th Street	060990005	2000	77	71	71	70	19	4	122
San Joaquin Valley	Tulare	Visalia-N Church Street	061072002	1999	123	121	114	114	28	4	117
San Joaquin Valley	Tulare	Visalia-N Church Street	061072002	2000	105	104	103	94	24	4	115
South Central Coast	San Luis Obispo	Atascadero-Lewis Avenue	060798001	1999	27	27	25	19	10	4	59
South Central Coast	San Luis Obispo	Atascadero-Lewis Avenue	060798001	2000	51	41	40	27	10	4	57
South Central Coast	San Luis Obispo	San Luis Obispo-Marsh Street	060792002	1999	20	17	16	16	8	4	54
South Central Coast	San Luis Obispo	San Luis Obispo-Marsh Street	060792002	2000	28	23	20	16			55
South Central Coast	Santa Barbara	Santa Barbara-W Carillo Street	60830010	1999	21	21	21	20			
South Central Coast	Santa Barbara	Santa Barbara-W Carillo Street	60830010	2000	24	24	22	17			
South Central Coast	Santa Barbara	Santa Maria-Broadway	60831007	1999	24	20	19	17			
South Central Coast	Santa Barbara	Santa Maria-Broadway	060831007	2000	29	19	15	14	10	4	57
South Central Coast	Ventura	El Rio-Rio Mesa School #2	061113001	1999	37	30	26	26	12	4	92
South Central Coast	Ventura	El Rio-Rio Mesa School #2	061113001	2000	46	36	32	29	13	4	106
South Central Coast	Ventura	Piru-3301 Pacific Avenue	61110009	2000	38	18	16	14			
South Central Coast	Ventura	Simi Valley-Cochran Street	061112002	1999	65	41	35	35	14	4	109
South Central Coast	Ventura	Simi Valley-Cochran Street	061112002	2000	55	44	42	37	15	4	102
South Central Coast	Ventura	Thousand Oaks-Moorpark Road	061110007	1999	53	39	31	31	12	4	110
South Central Coast	Ventura	Thousand Oaks-Moorpark Road	061110007	2000	54	44	42	41	13	4	103
South Coast	Los Angeles	Azusa	060370002	1999	81	72	66	64	25	4	144
South Coast	Los Angeles	Azusa	060370002	2000	92	79	78	75	20	4	333
South Coast	Los Angeles	Burbank-W Palm Avenue	060371002	1999	79	50	50	48	23	4	106
South Coast	Los Angeles	Burbank-W Palm Avenue	060371002	2000	84	83	68	56			70
South Coast	Los Angeles	Los Angeles-North Main Street	060371103	1999	69	68	52	43	23	4	136

Appendix 6-B
PM2.5 Air Quality Data

Basin Name	County Name	Site Name	AIRS Site Id	Year	1st High	2nd High	3rd High	4th High	Average of Quarters	Valid Qtrs	Number of Obs.
South Coast	Los Angeles	Los Angeles-North Main Street	060371103	2000	88	85	81	76	22	4	334
South Coast	Los Angeles	Lynwood	060371301	1999	68	54	53	49	24	4	110
South Coast	Los Angeles	Lynwood	060371301	2000	82	69	63	62	23	4	121
South Coast	Los Angeles	North Long Beach	060374002	1999	67	54	50	48	21	4	148
South Coast	Los Angeles	North Long Beach	060374002	2000	82	74	69	66	20	4	304
South Coast	Los Angeles	Pasadena-S Wilson Avenue	060372005	1999	73	60	41	40			95
South Coast	Los Angeles	Pasadena-S Wilson Avenue	060372005	2000	66	64	54	52	19	4	110
South Coast	Los Angeles	Pico Rivera	060371601	1999	86	70	60	53	26	4	111
South Coast	Los Angeles	Pico Rivera	060371601	2000	90	78	71	68	24	4	116
South Coast	Los Angeles	Reseda	060371201	1999	79	40	39	37			71
South Coast	Los Angeles	Reseda	060371201	2000	68	66	50	47	18	4	108
South Coast	Orange	Anaheim-Harbor Blvd	060590001	1999	69	66	62	54			92
South Coast	Orange	Anaheim-Harbor Blvd	060590001	2000	114	99	88	84	20	4	273
South Coast	Orange	Mission Viejo-26081 Via Pera	060592022	1999	57	45	44	33			65
South Coast	Orange	Mission Viejo-26081 Via Pera	060592022	2000	95	58	36	36	15	4	119
South Coast	Riverside	Riverside-Magnolia	060651003	1999	90	72	62	62	27	4	110
South Coast	Riverside	Riverside-Magnolia	060651003	2000	79	78	67	67	25	4	111
South Coast	Riverside	Riverside-Rubidoux	060658001	1999	111	92	79	75	31	4	137
South Coast	Riverside	Riverside-Rubidoux	060658001	2000	120	100	89	84	28	4	282
South Coast	San Bernardino	Big Bear City-501 W. Valley Blvd	060718001	1999	32	31	27	25	10	4	97
South Coast	San Bernardino	Big Bear City-501 W. Valley Blvd	060718001	2000	29	27	25	25			59
South Coast	San Bernardino	Fontana-Arrow Highway	060712002	1999	98	96	66	62	26	4	121
South Coast	San Bernardino	Fontana-Arrow Highway	060712002	2000	73	68	65	65	24	4	112
South Coast	San Bernardino	Ontario-1408 Francis Street	060710025	1999	86	86	64	63	25	4	96
South Coast	San Bernardino	Ontario-1408 Francis Street	060710025	2000	73	72	65	64	24	4	111
South Coast	San Bernardino	San Bernardino-4th Street	060719004	1999	121	74	72	66	26	4	104
South Coast	San Bernardino	San Bernardino-4th Street	060719004	2000	90	70	64	59	26	4	92

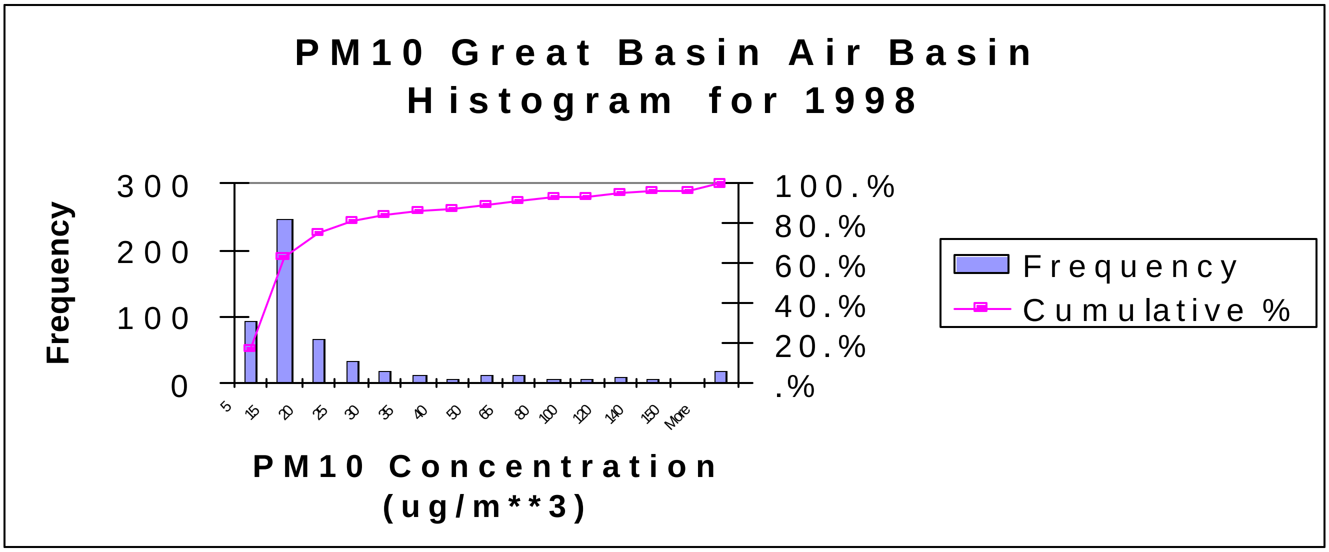
Appendix 6

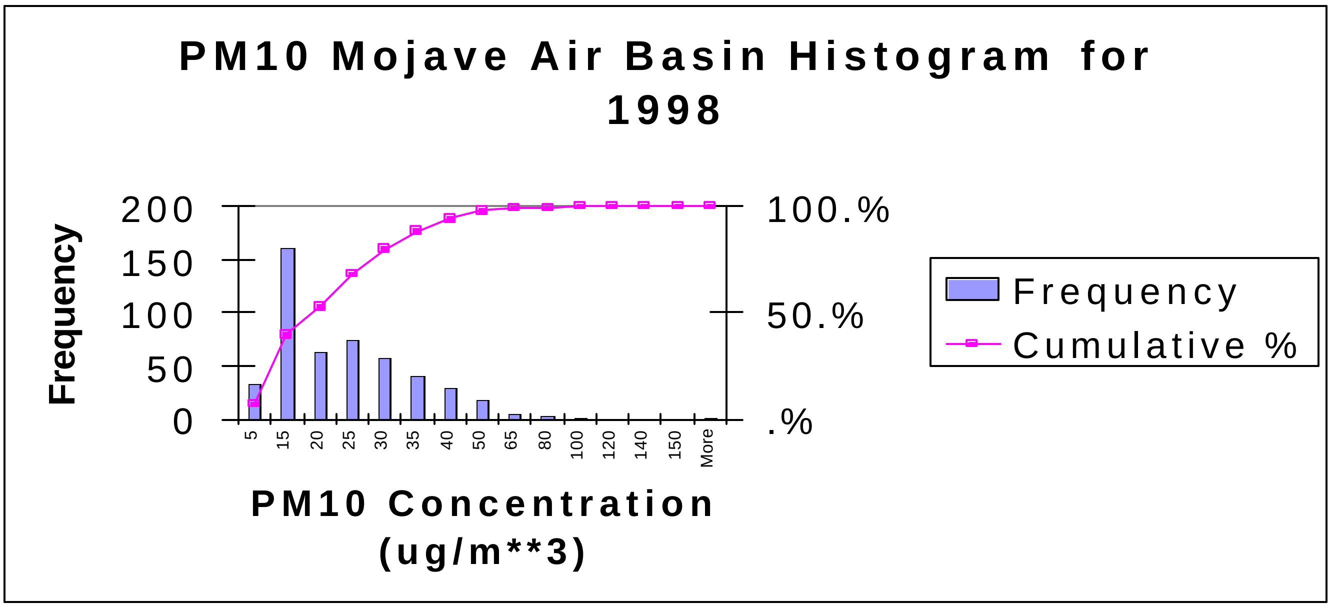
Supplementary Material for Chapter 6

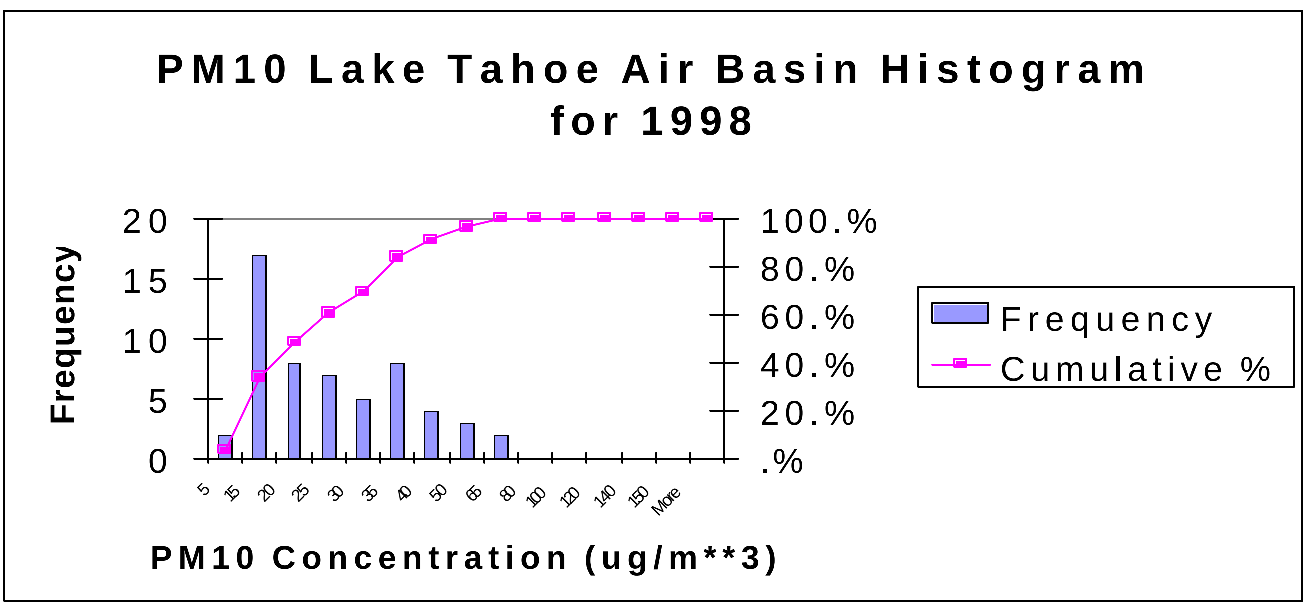
Part C

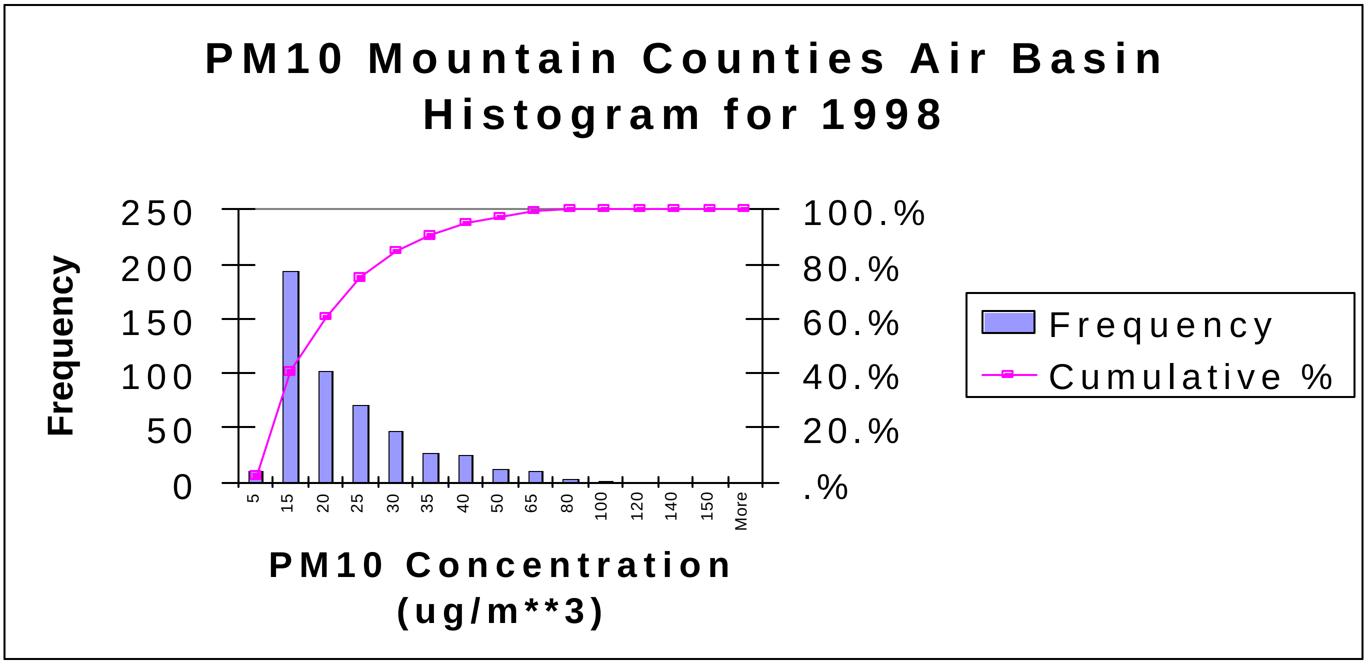
PM10 Histograms for 1998-2000

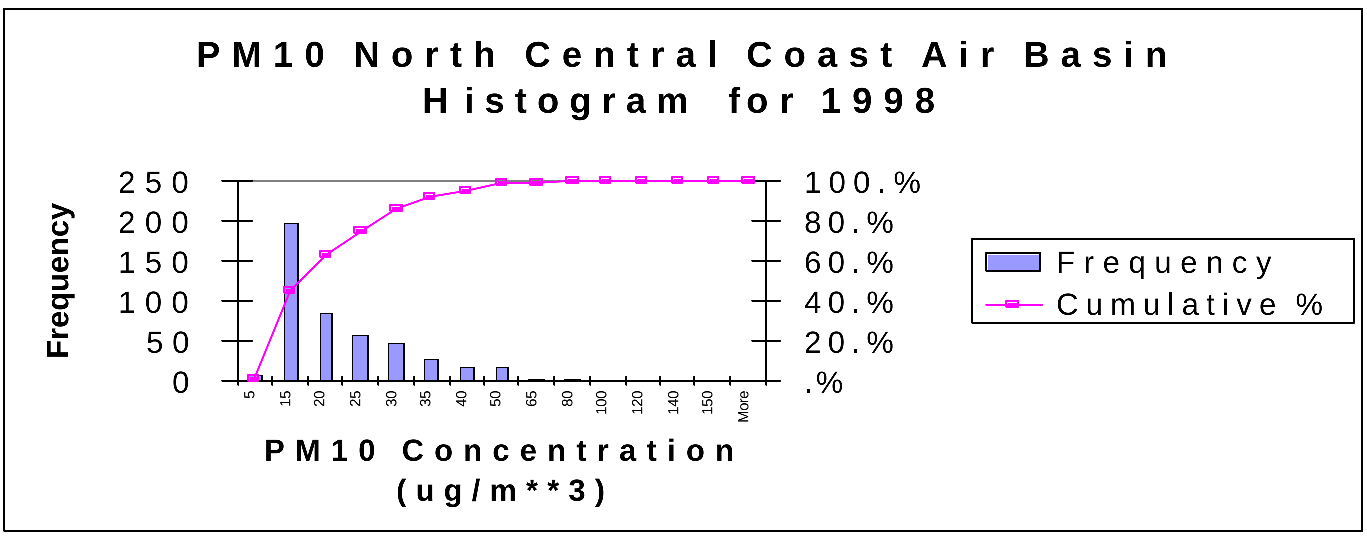
PM10 HISTOGRAMS FOR 1998

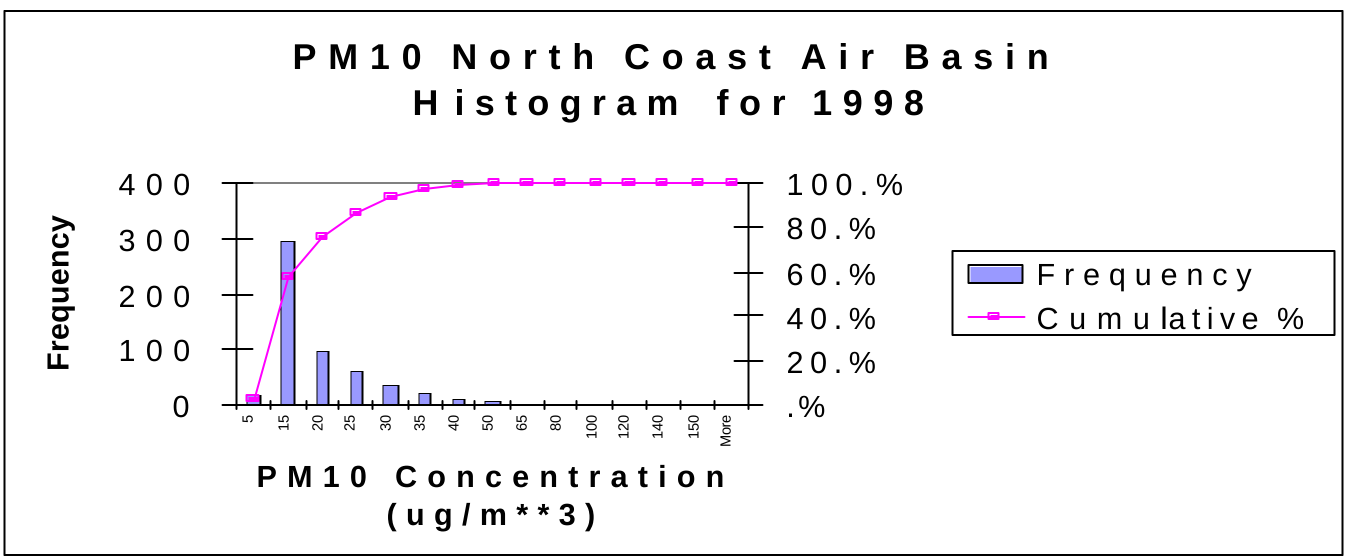

PM10 Great Basin Air Basin Histogram for 1998
Frequency
300
200
100
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %

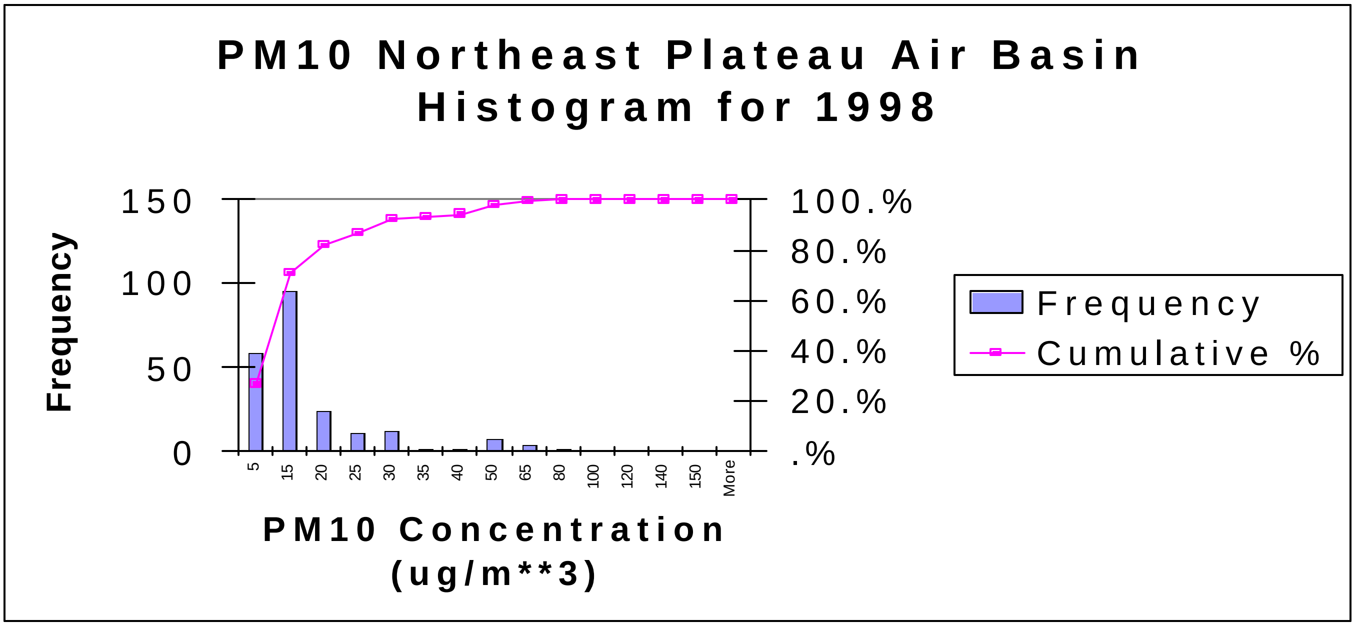

PM10 Mojave Air Basin Histogram for 1998
Frequency
200
150
100
50
0
100.%
50.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %

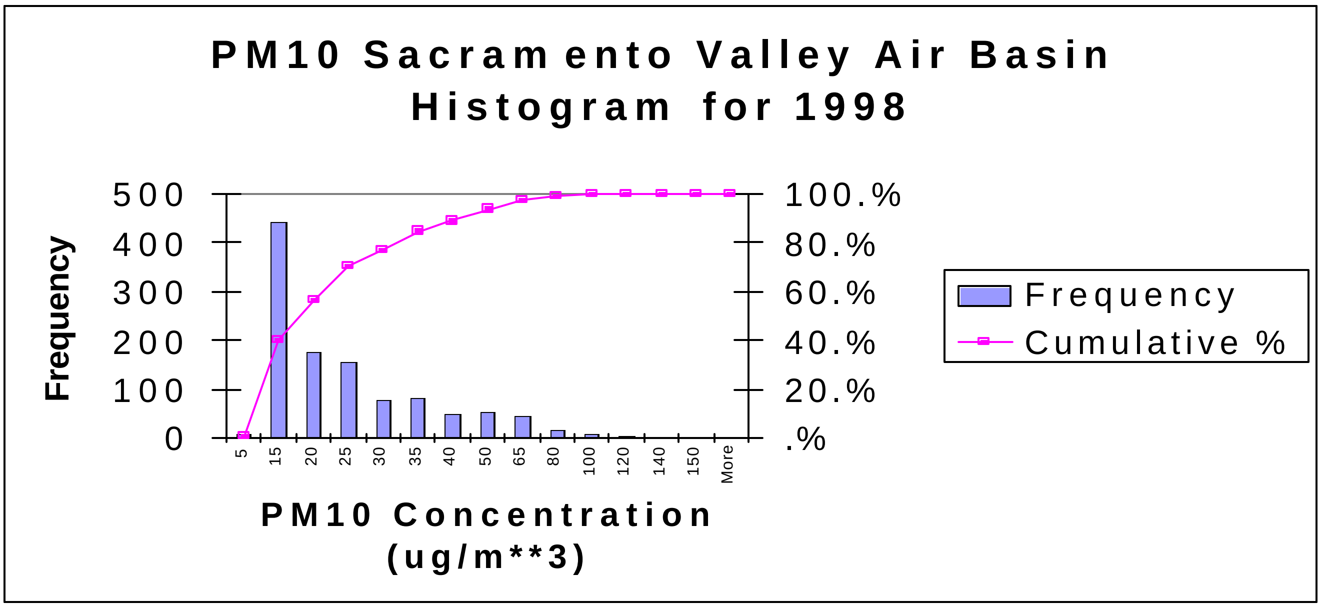

PM10 Lake Tahoe Air Basin Histogram for 1998
Frequency
20
15
10
5
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %

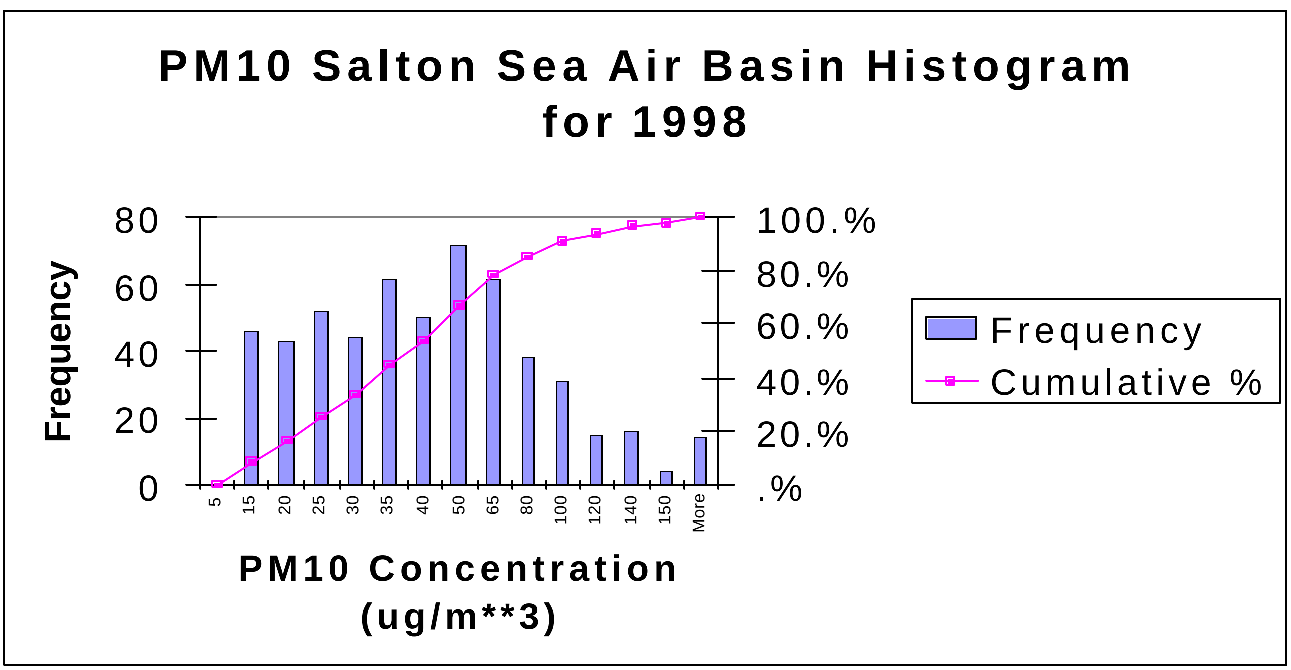

PM10 Mountain Counties Air Basin
Histogram for 1998
Frequency
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %


PM10 North Central Coast Air Basin
Histogram for 1998
Frequency
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %

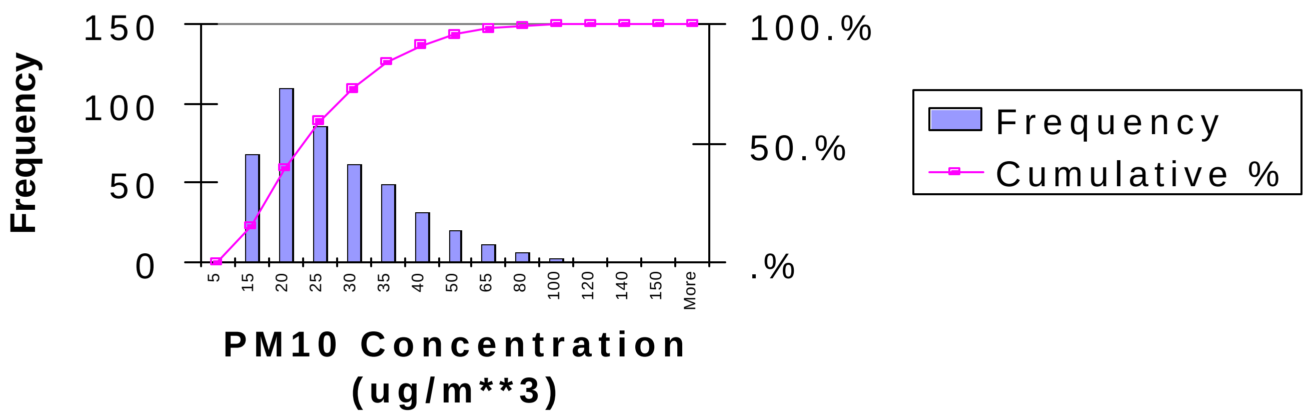

PM10 North Coast Air Basin
Histogram for 1998
Frequency
400
300
200
100
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %


PM10 Northeast Plateau Air Basin
Histogram for 1998
Frequency
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %

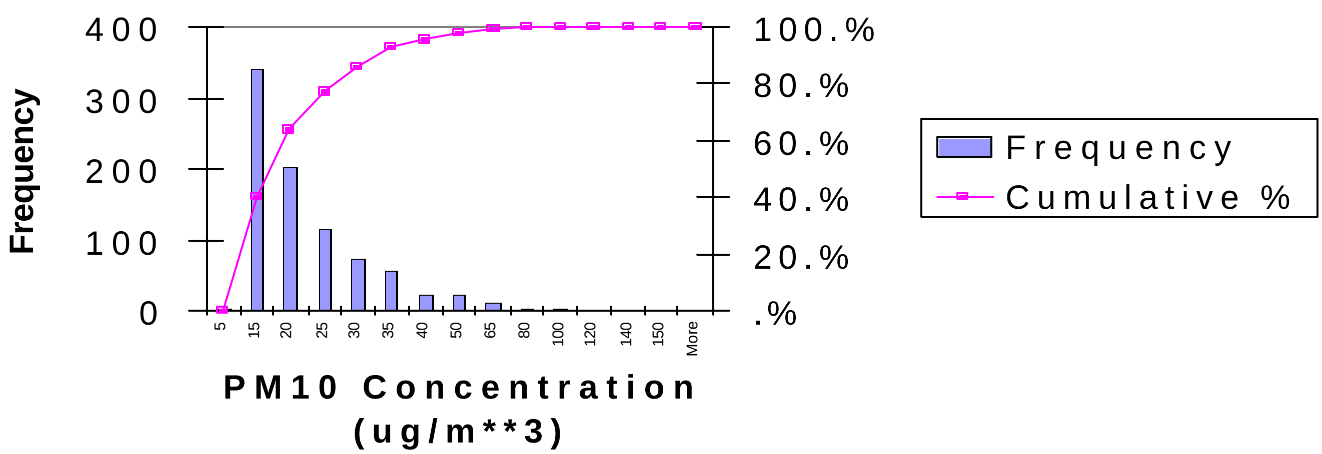

PM10 Sacramento Valley Air Basin
Histogram for 1998
Frequency
500
400
300
200
100
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %


PM10 Salton Sea Air Basin Histogram
for 1998
Frequency
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %

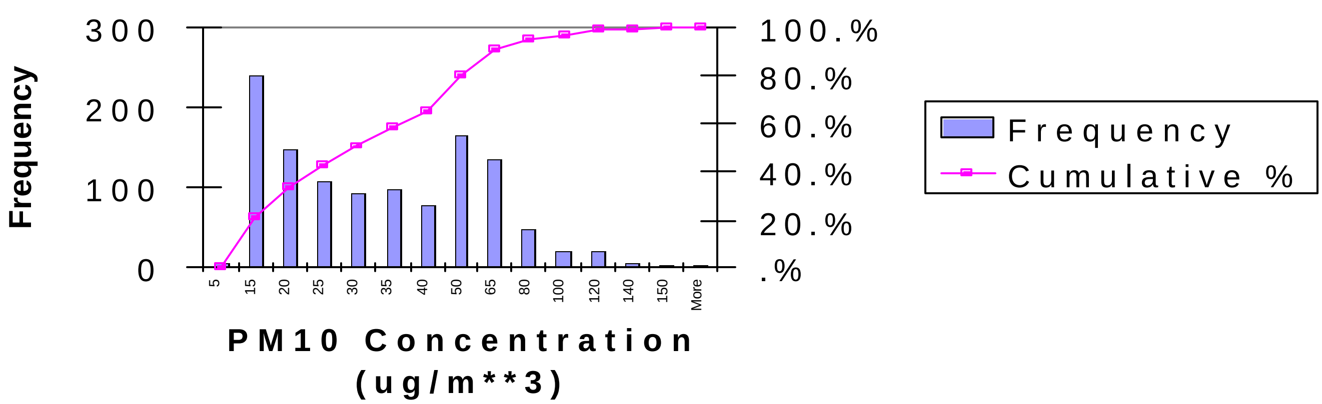
PM10 San Diego Air Basin Histogram for 1998

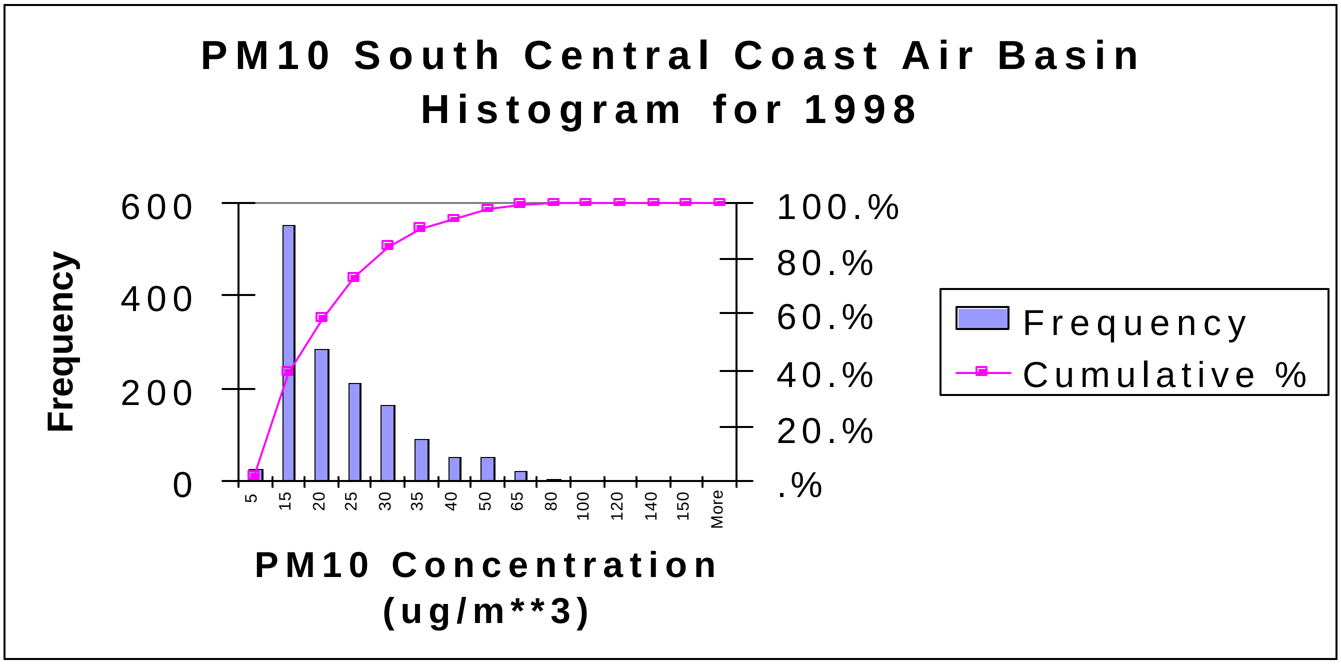


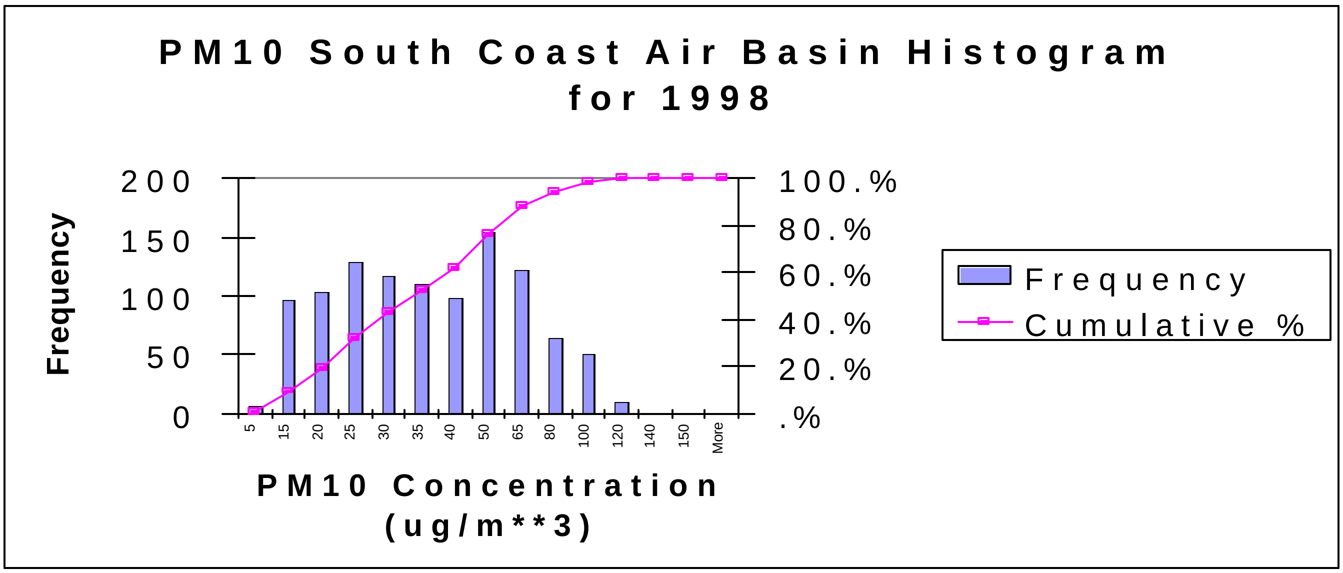
PM10 San Francisco Bay Area Air Basin Histogram for 1998



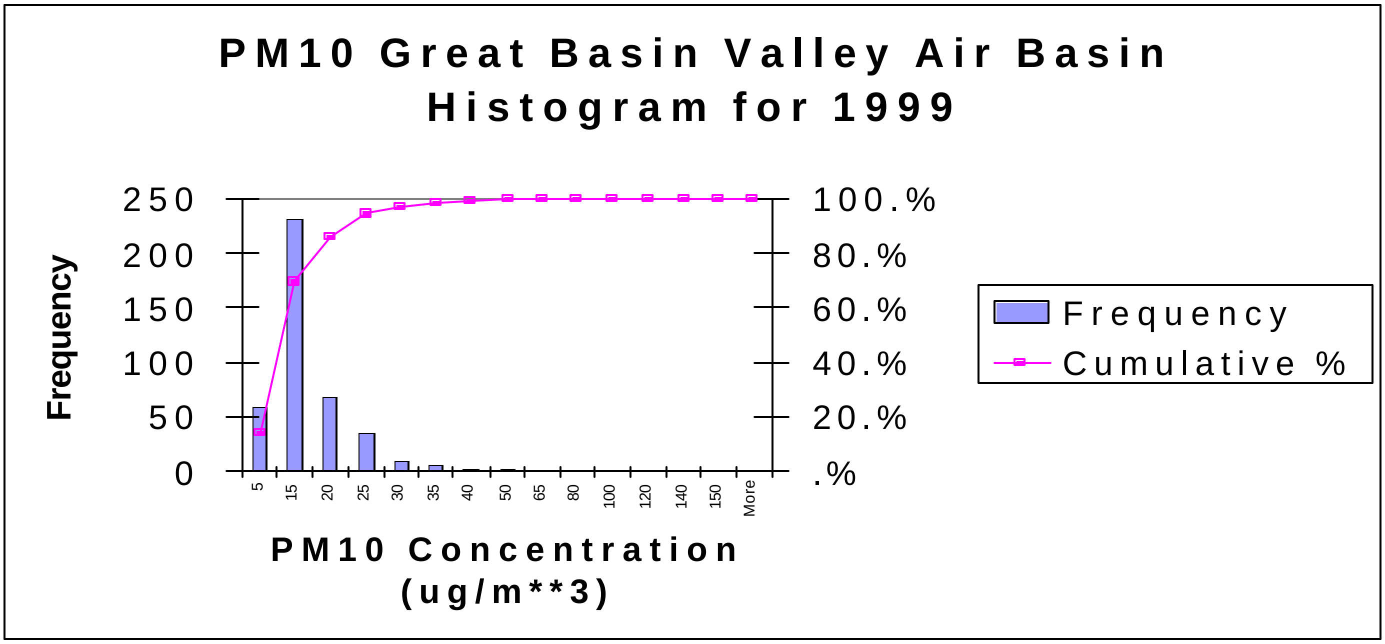
PM10 San Joaquin Valley Air Basin Histogram for 1998

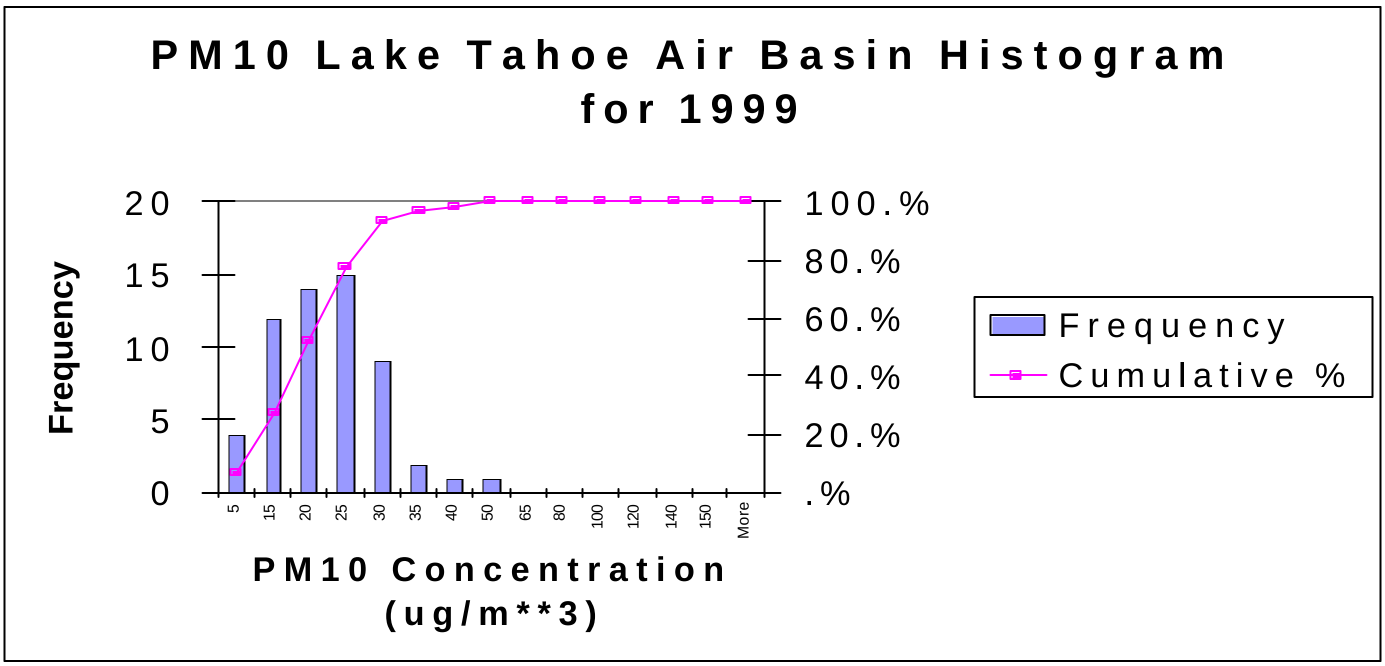


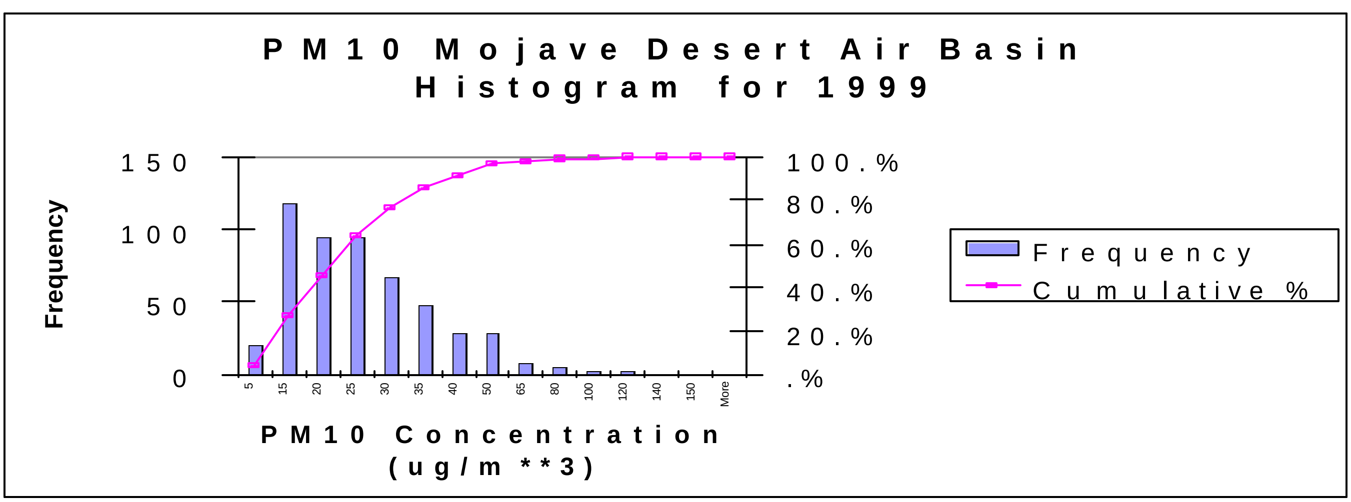

PM10 South Central Coast Air Basin Histogram for 1998
Frequency
600
400
200
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %

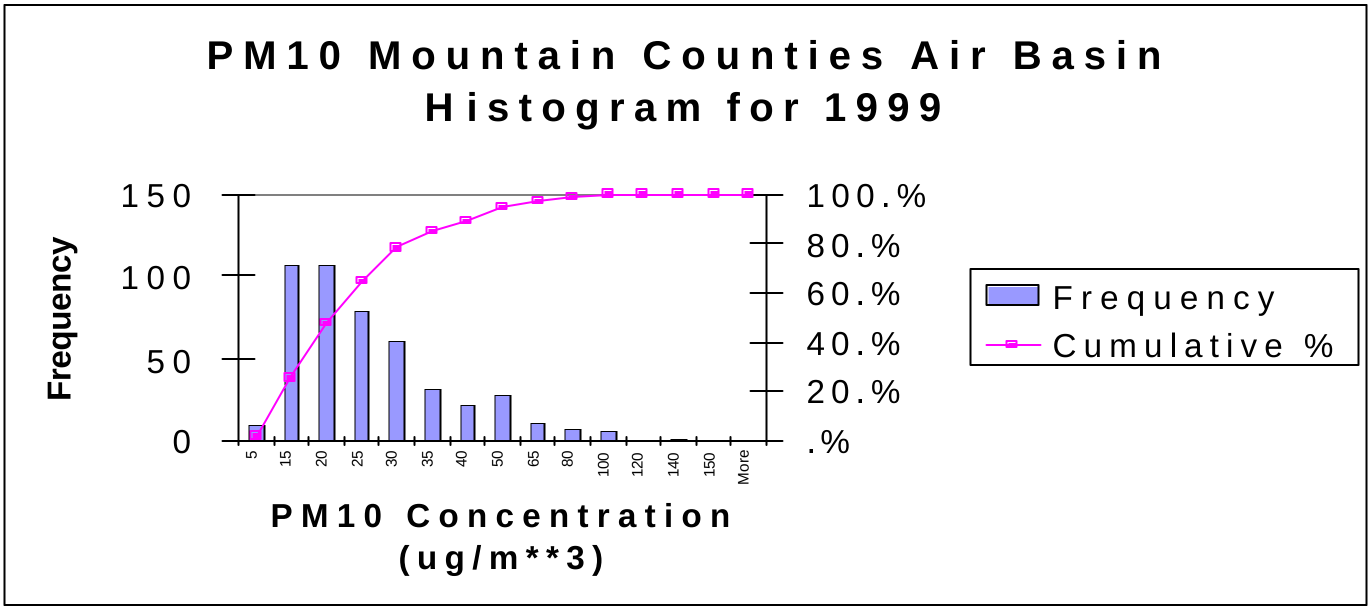

PM10 South Coast Air Basin Histogram for 1998
Frequency
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %

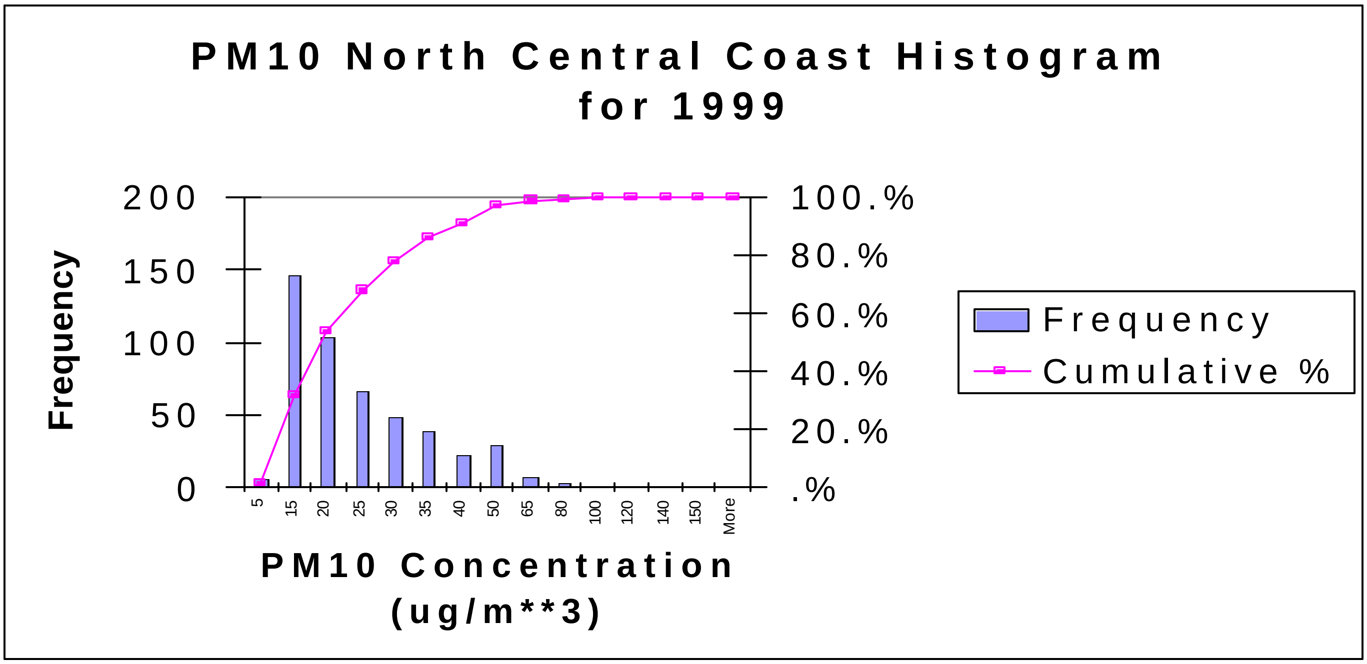
PM10 HISTOGRAMS FOR 1999

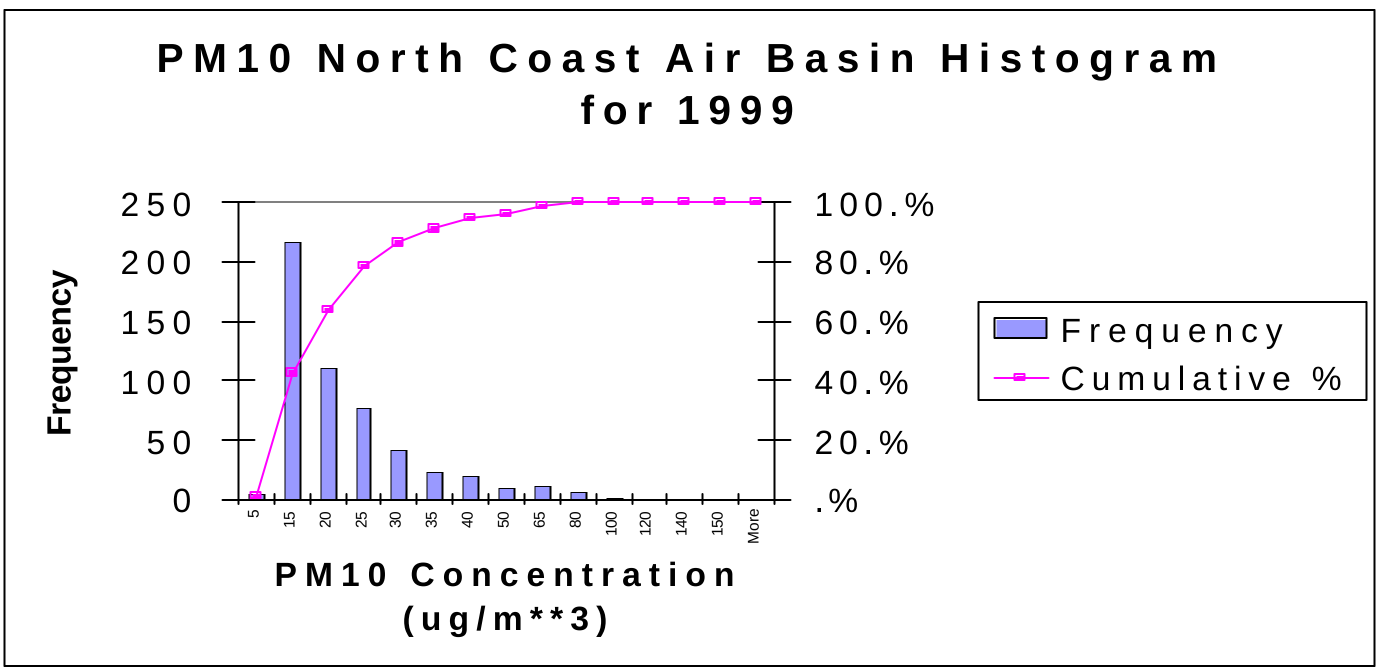

PM10 Great Basin Valley Air Basin Histogram for 1999
Frequency
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %

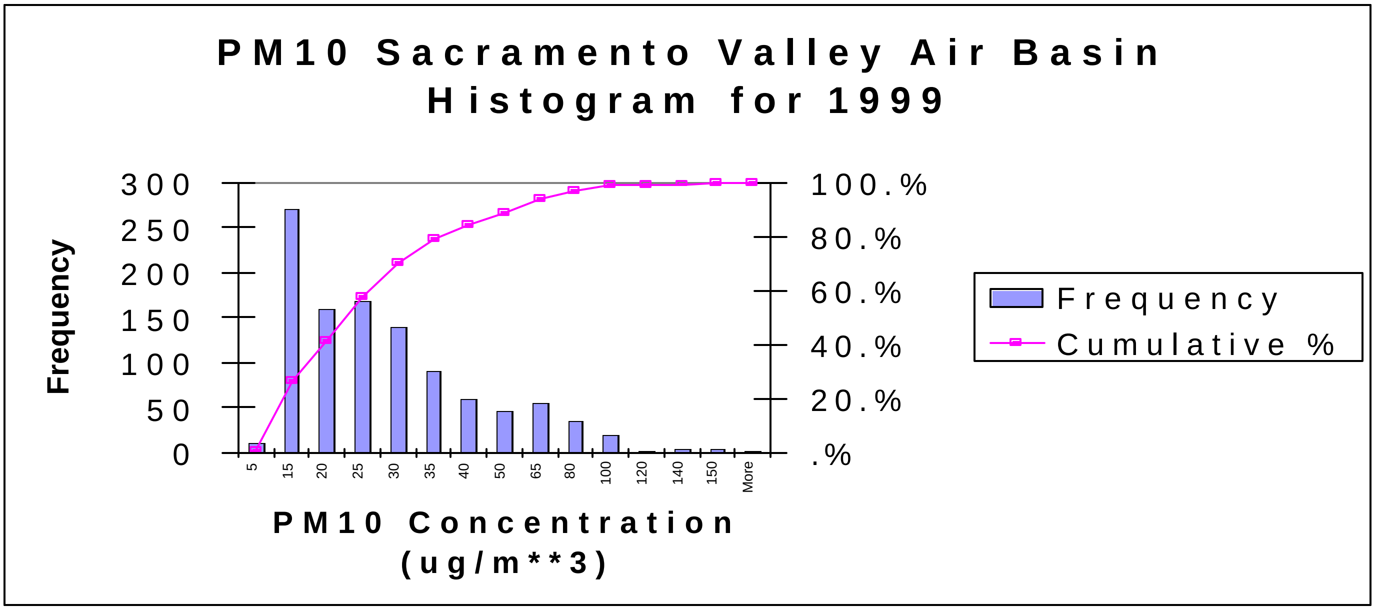

PM10 Lake Tahoe Air Basin Histogram for 1999
Frequency
20
15
10
5
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %


PM10 Mojave Desert Air Basin Histogram for 1999
Frequency
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m **3)
Frequency
Cumulative %

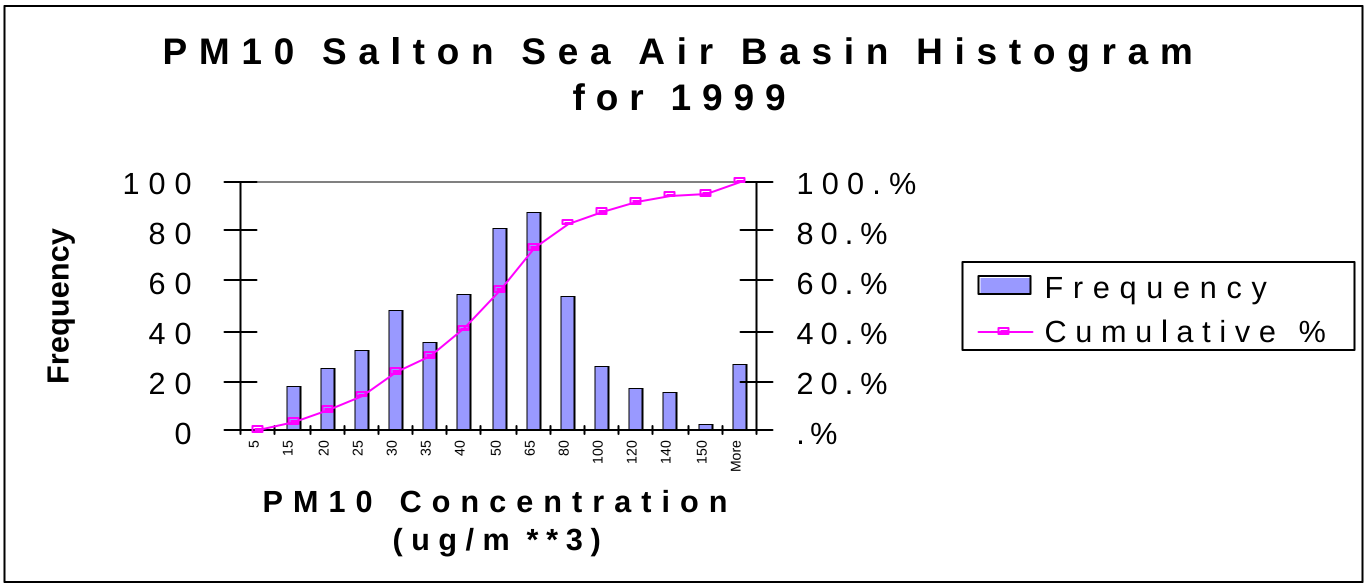

PM10 Mountain Counties Air Basin
Histogram for 1999
Frequency
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %


PM10 North Central Coast Histogram
for 1999
Frequency
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %

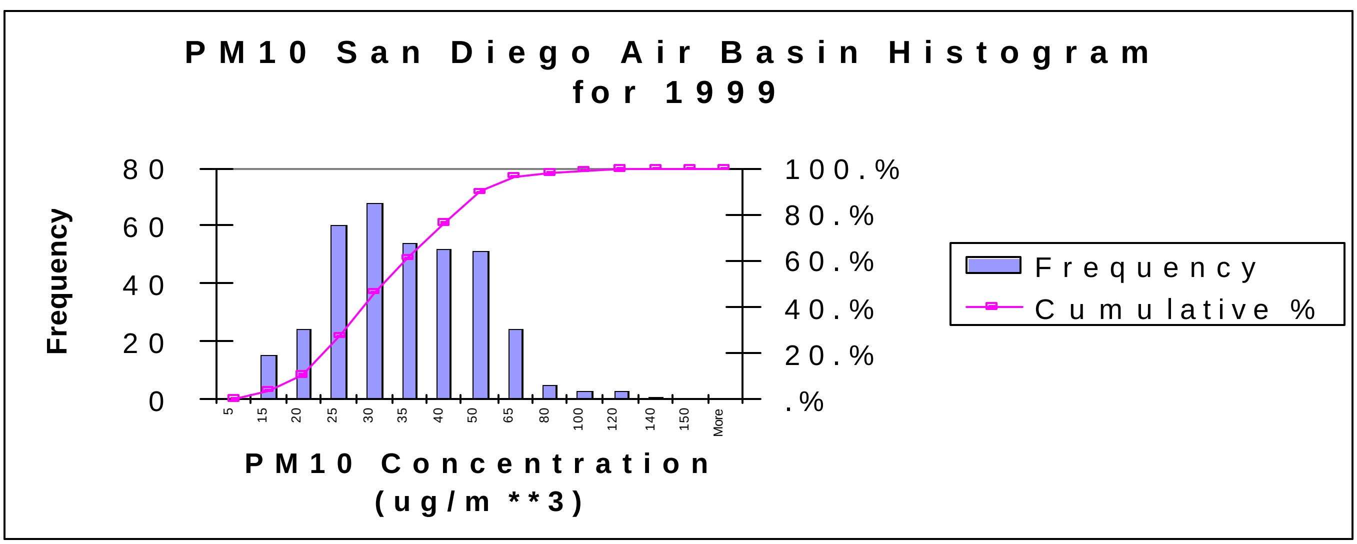

PM10 North Coast Air Basin Histogram
for 1999
Frequency
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %



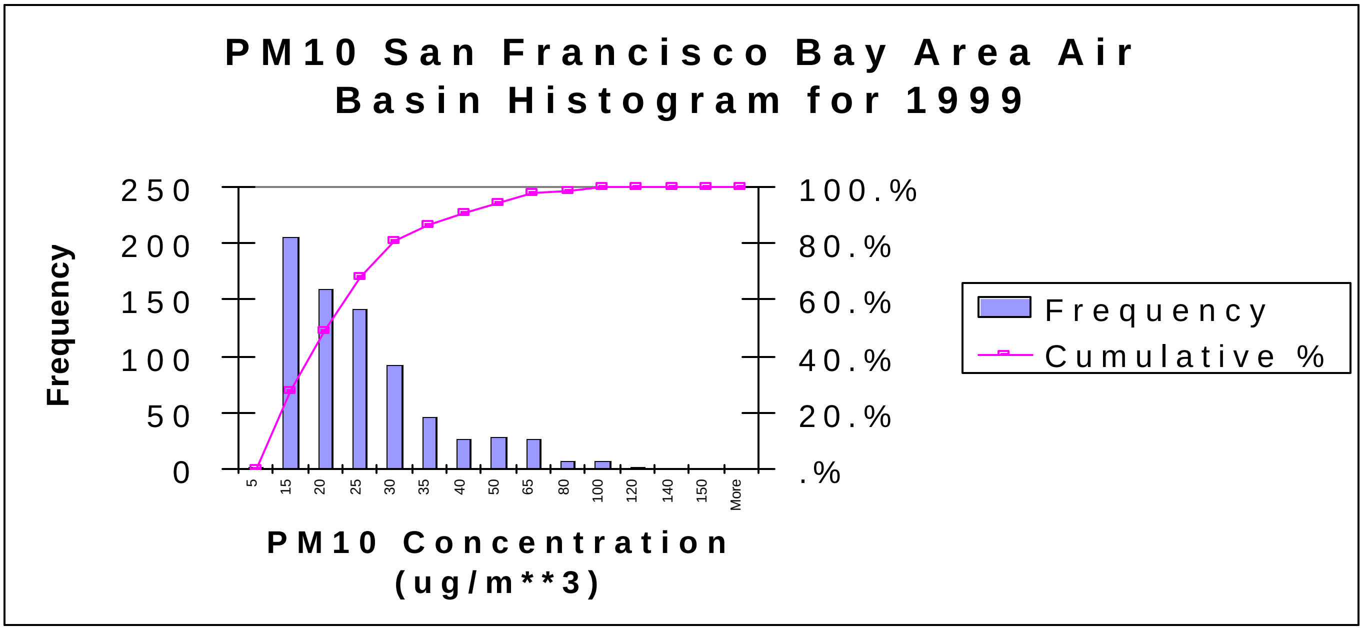
PM10 Sacramento Valley Air Basin Histogram for 1999
Frequency
300
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %



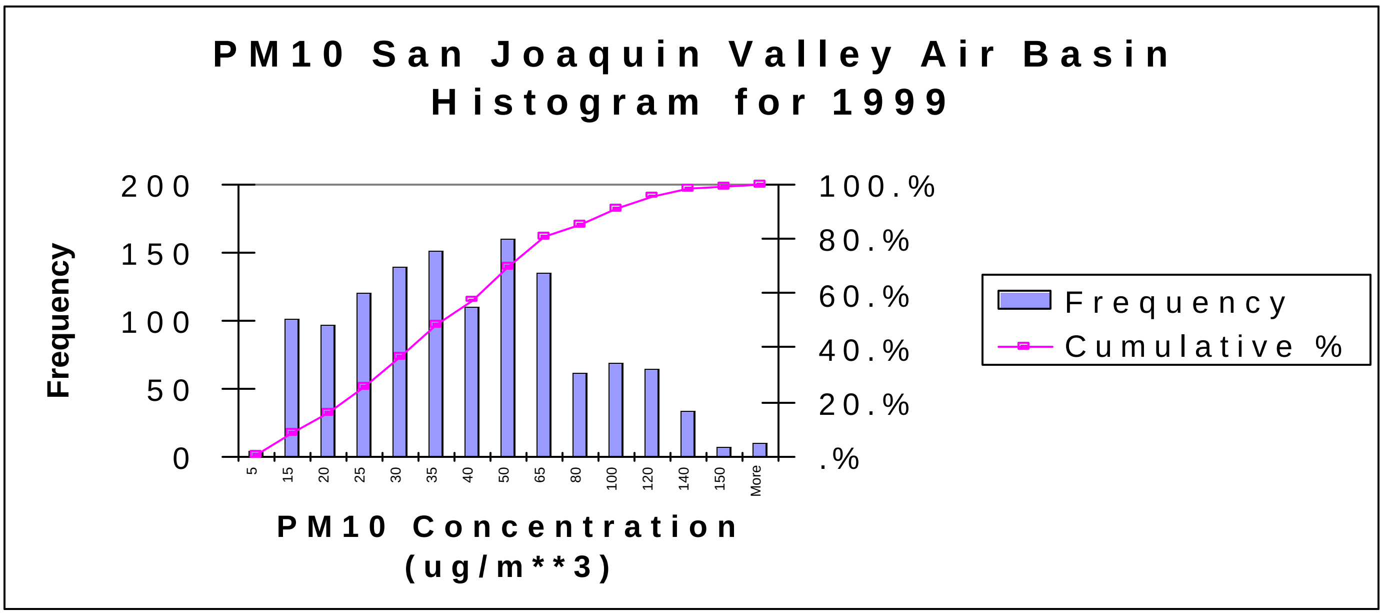
PM10 Salton Sea Air Basin Histogram for 1999
Frequency
100
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m **3)
Frequency
Cumulative %



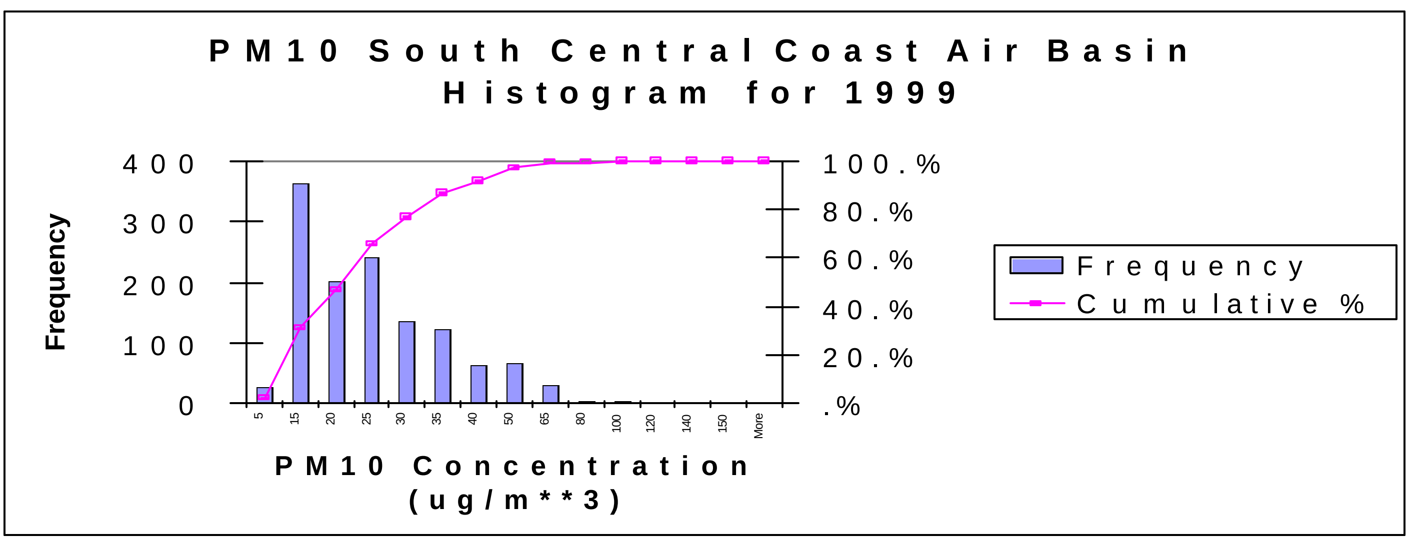
PM10 San Diego Air Basin Histogram for 1999
Frequency
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m **3)
Frequency
Cumulative %



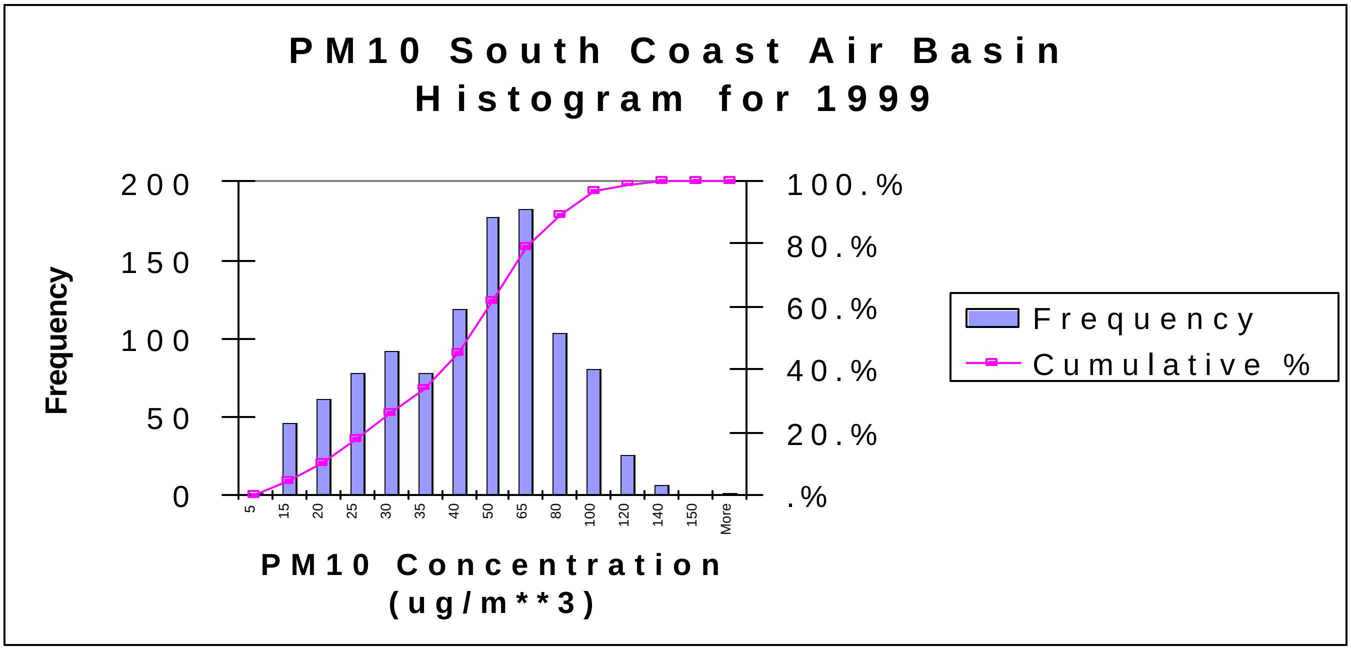
PM10 San Francisco Bay Area Air Basin Histogram for 1999
250
200
150
100
50
0
Frequency
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
Frequency
Cumulative %
PM10 Concentration (ug/m**3)



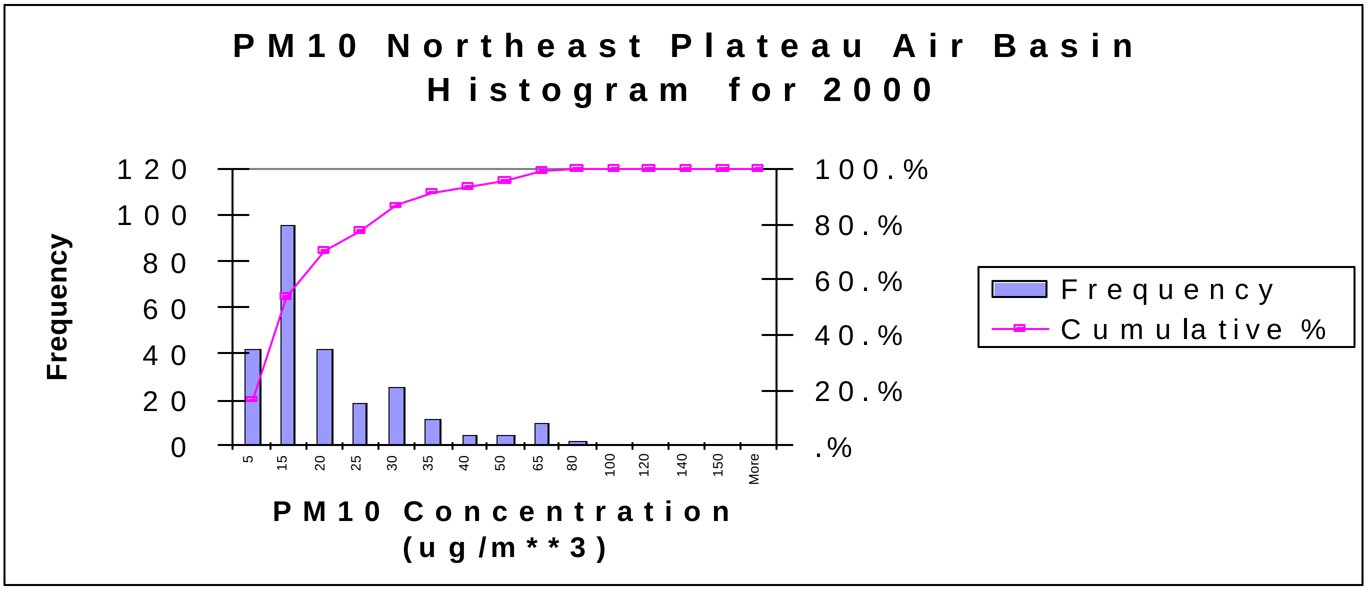
PM10 San Joaquin Valley Air Basin Histogram for 1999
200
150
100
50
0
Frequency
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
Frequency
Cumulative %
PM10 Concentration (ug/m**3)

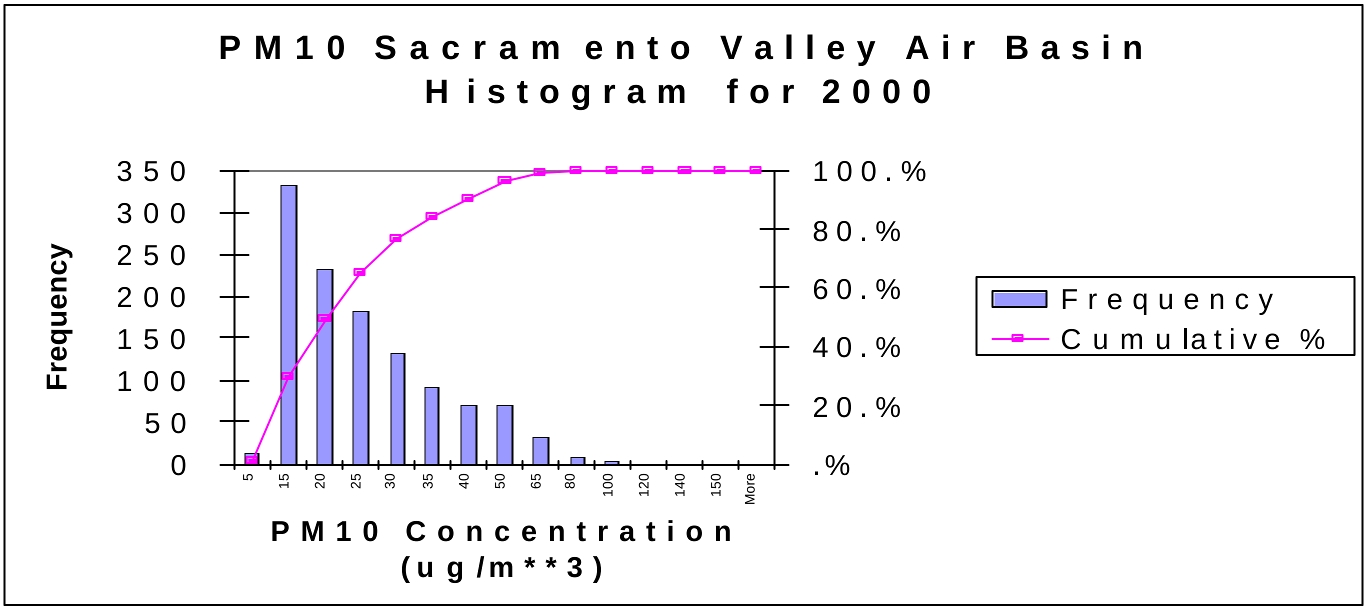


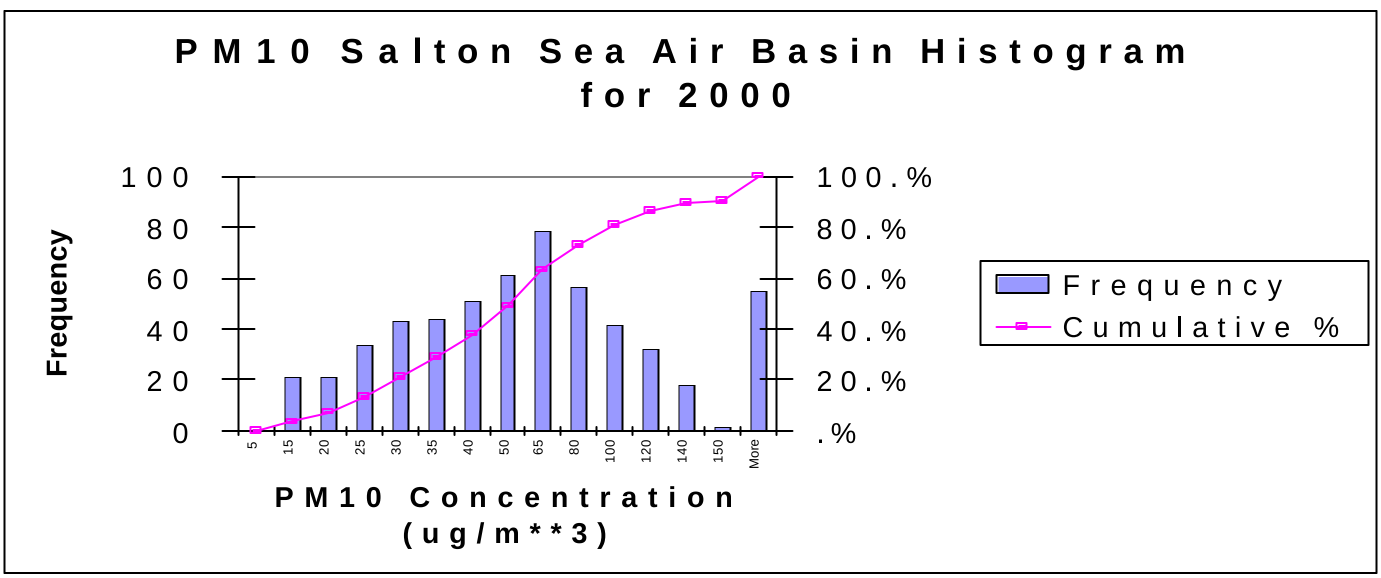
PM10 South Central Coast Air Basin Histogram for 1999
400
300
200
100
0
Frequency
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
Frequency
Cumulative %
PM10 Concentration (ug/m**3)

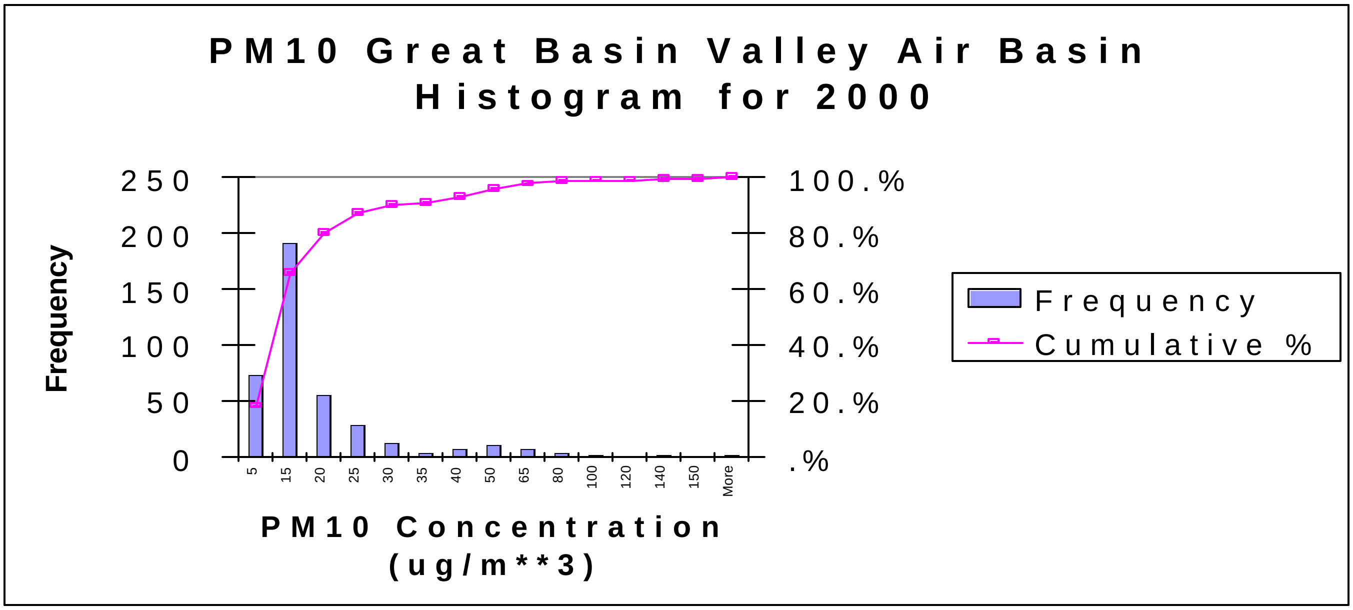

PM10 South Coast Air Basin
Histogram for 1999
Frequency
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %

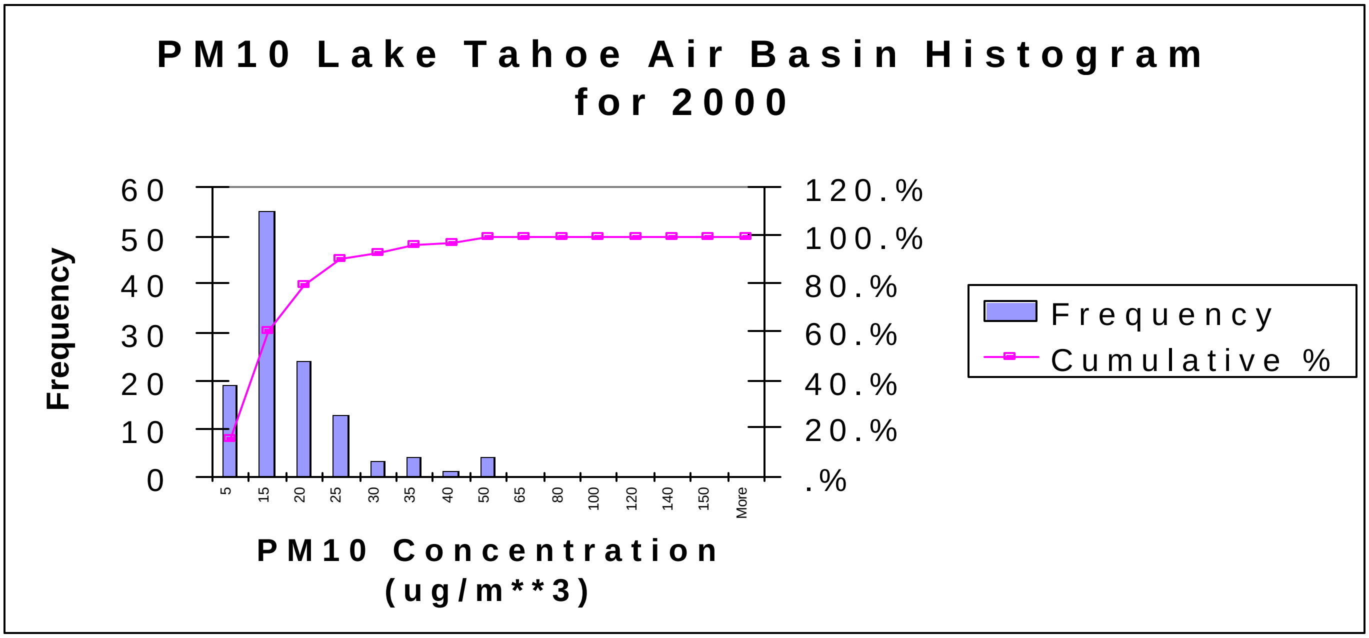
PM10 HISTOGRAMS FOR 2000

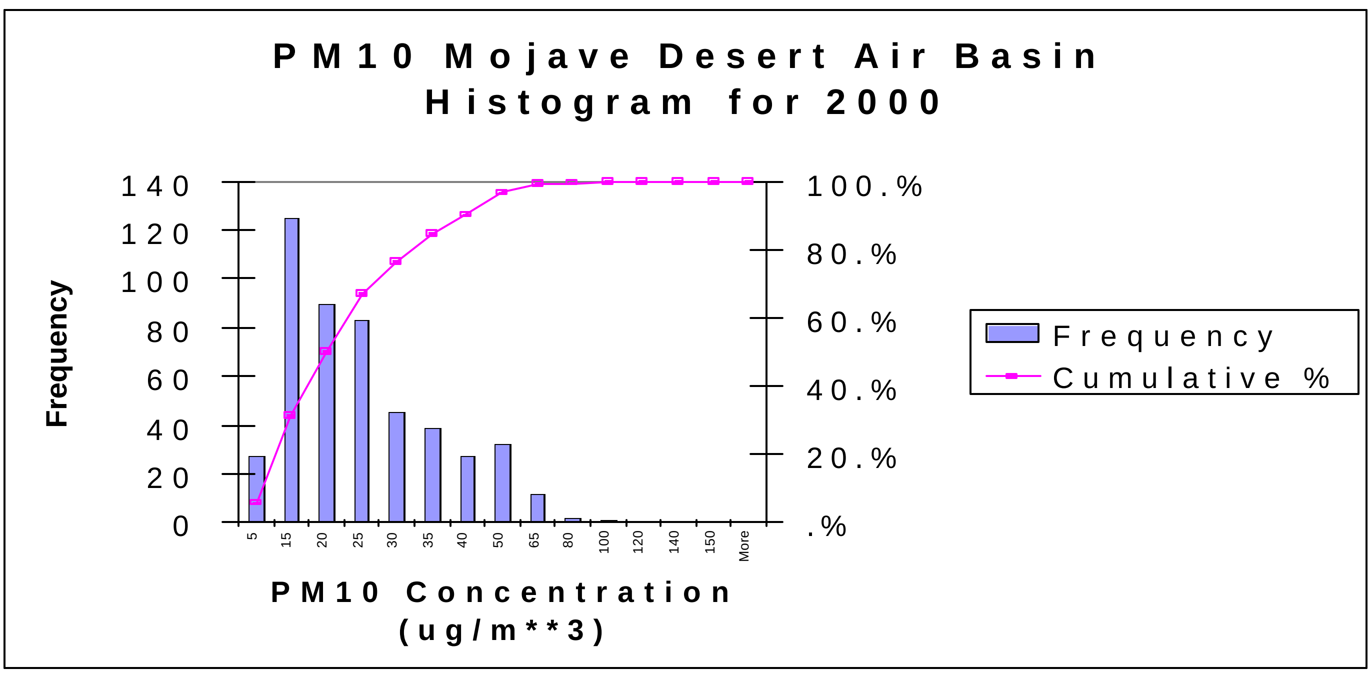

PM10 Northeast Plateau Air Basin
Histogram for 2000
Frequency
120
100
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %

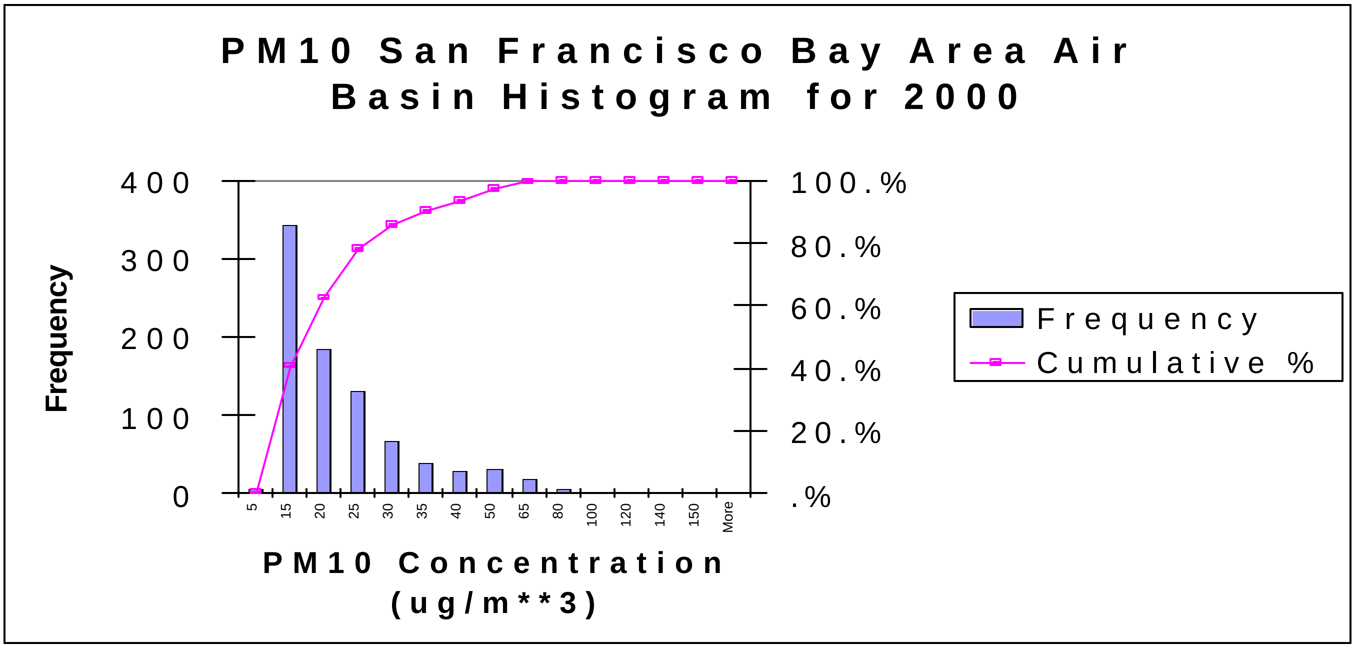

PM10 Sacramento Valley Air Basin
Histogram for 2000
Frequency
350
300
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %

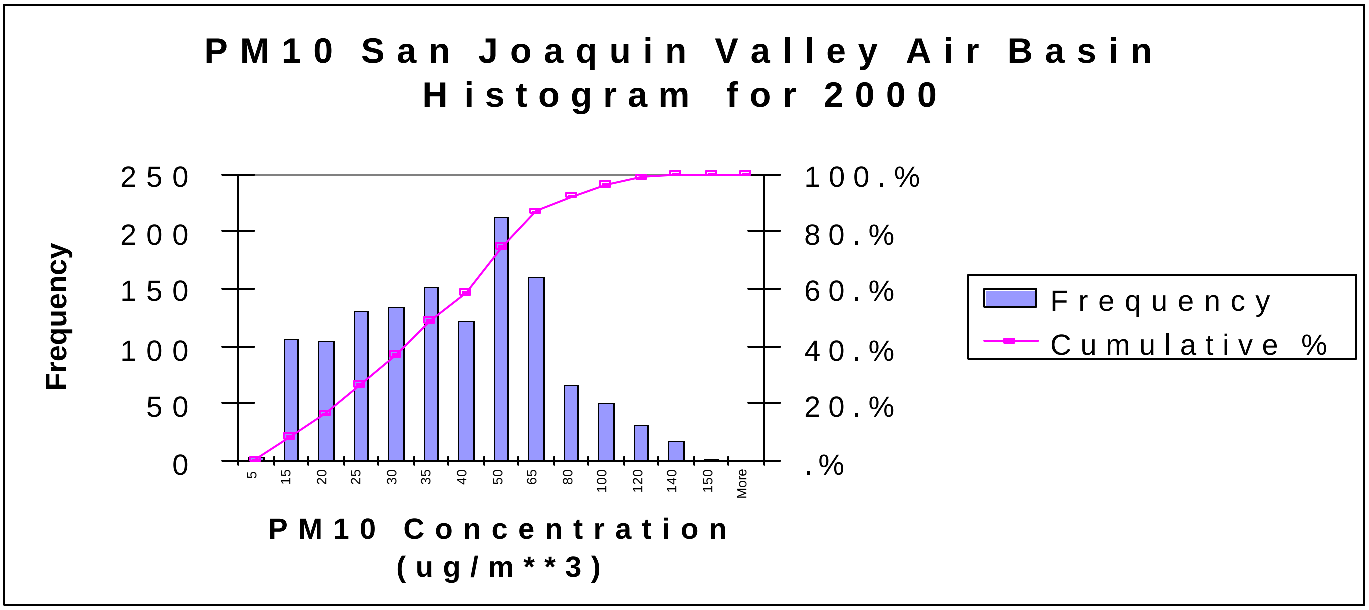

PM10 Salton Sea Air Basin Histogram
for 2000
Frequency
100
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %

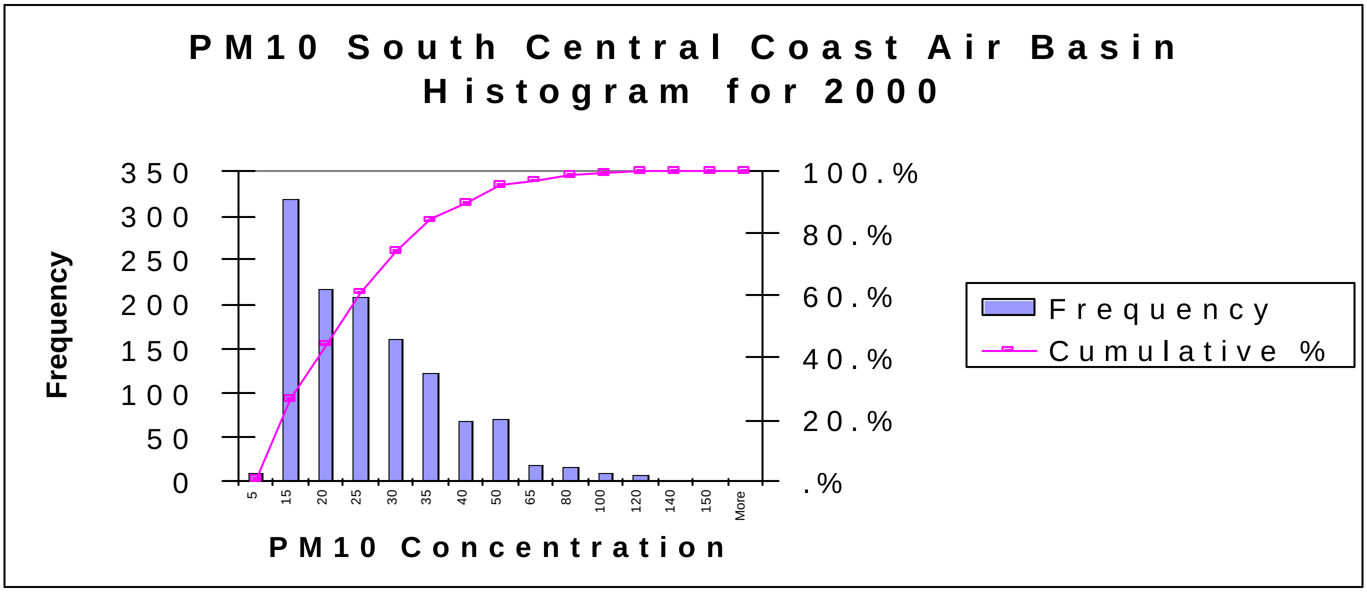

PM10 Great Basin Valley Air Basin Histogram for 2000
Frequency
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5 15 20 25 30 35 40 50 65 80 100 120 140 150 More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %

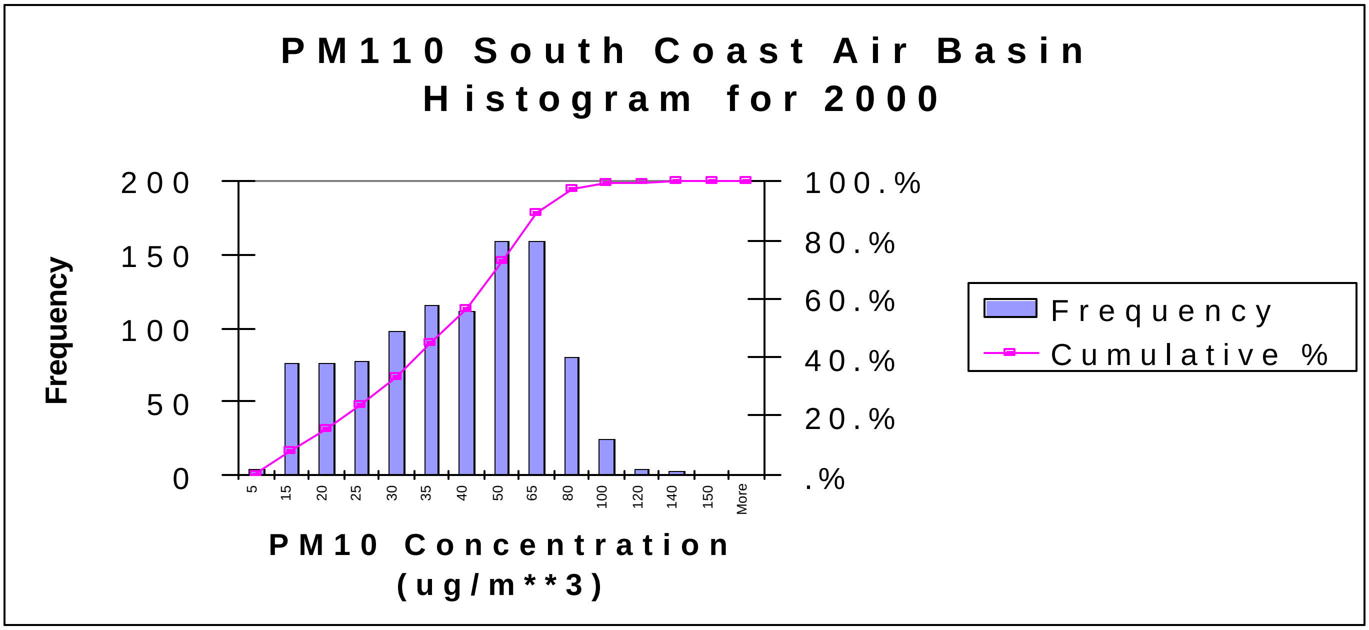

PM10 Lake Tahoe Air Basin Histogram for 2000
Frequency
60
50
40
30
20
10
0
120.%
100.%
80.%
60.%
40.%
20.%
.%
5 15 20 25 30 35 40 50 65 80 100 120 140 150 More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %


PM10 Mojave Desert Air Basin Histogram for 2000
Frequency
140
120
100
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
5 15 20 25 30 35 40 50 65 80 100 120 140 150 More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %


PM10 San Francisco Bay Area Air Basin Histogram for 2000
Frequency
400
300
200
100
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %


PM10 San Joaquin Valley Air Basin Histogram for 2000
Frequency
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration (ug/m**3)
Frequency
Cumulative %


PM10 South Central Coast Air Basin Histogram for 2000
Frequency
350
300
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
Frequency
Cumulative %



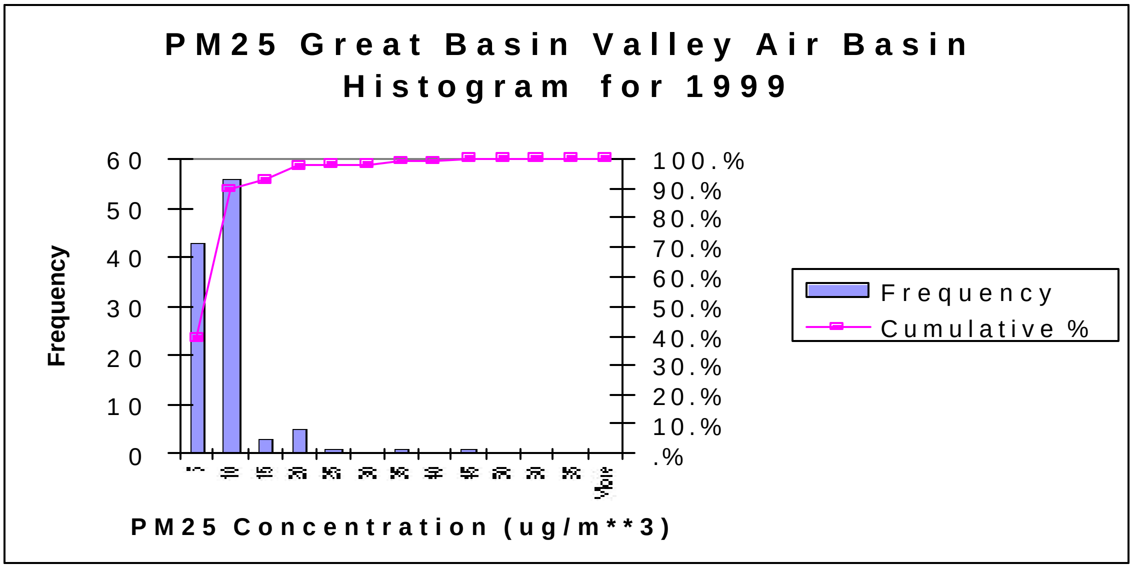
PM110 South Coast Air Basin
Histogram for 2000
Frequency
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
5
15
20
25
30
35
40
50
65
80
100
120
140
150
More
PM10 Concentration
(ug/m**3)
Frequency
Cumulative %

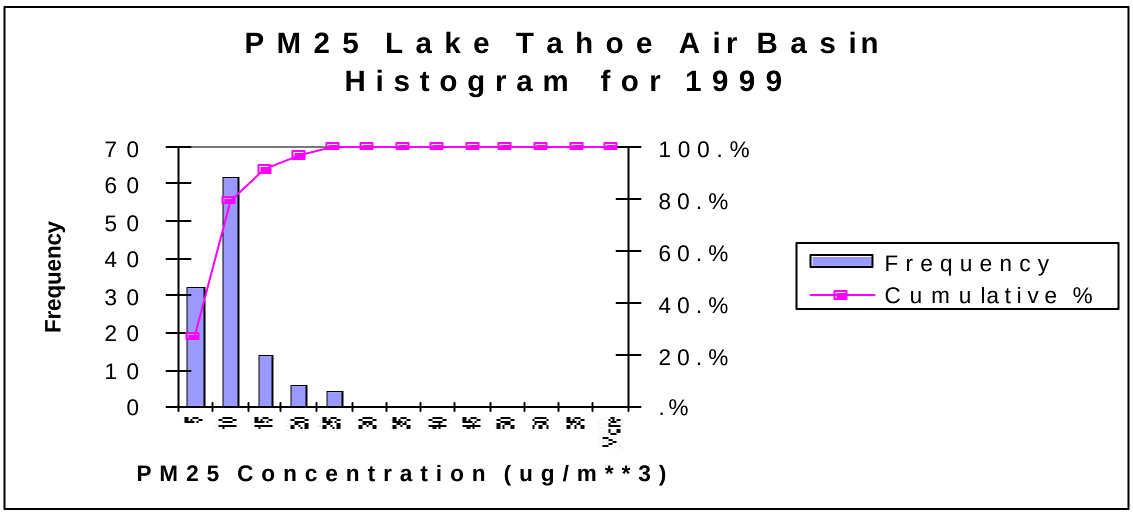
Appendix 6

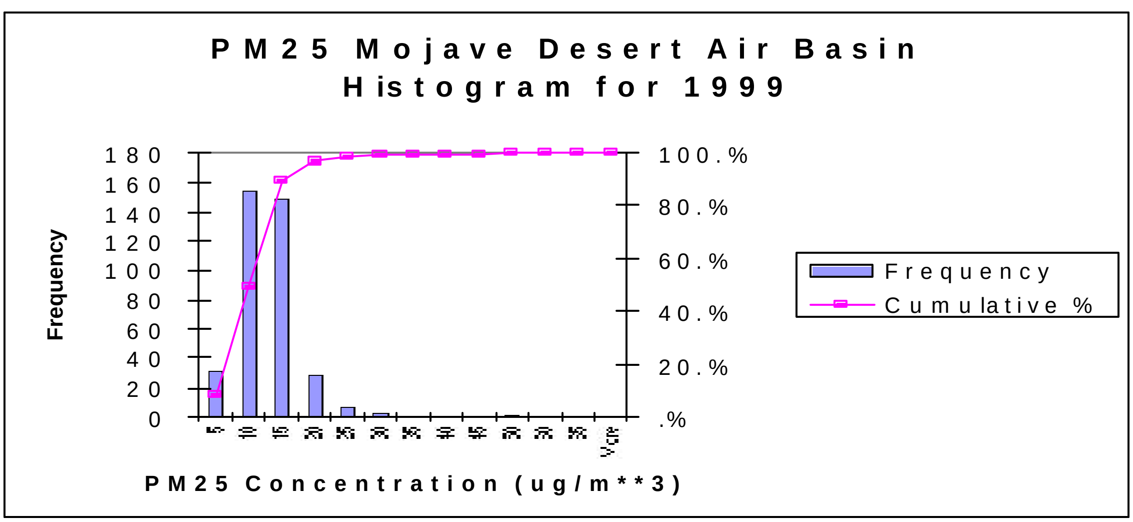
Supplementary Material for Chapter 6

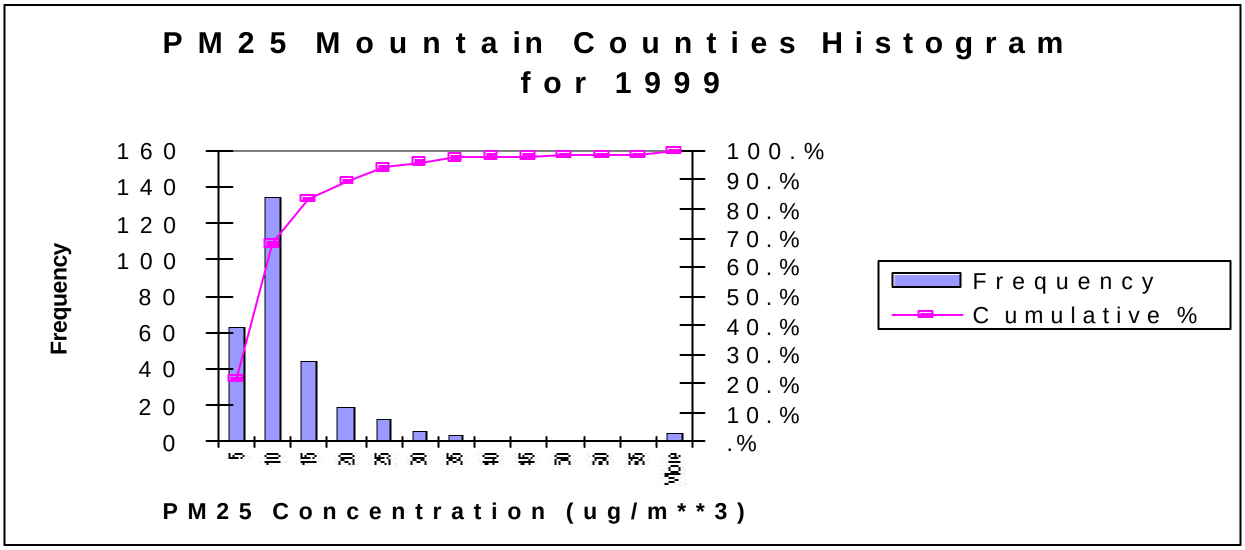
Part D
PM25 Histograms for 1999-2000

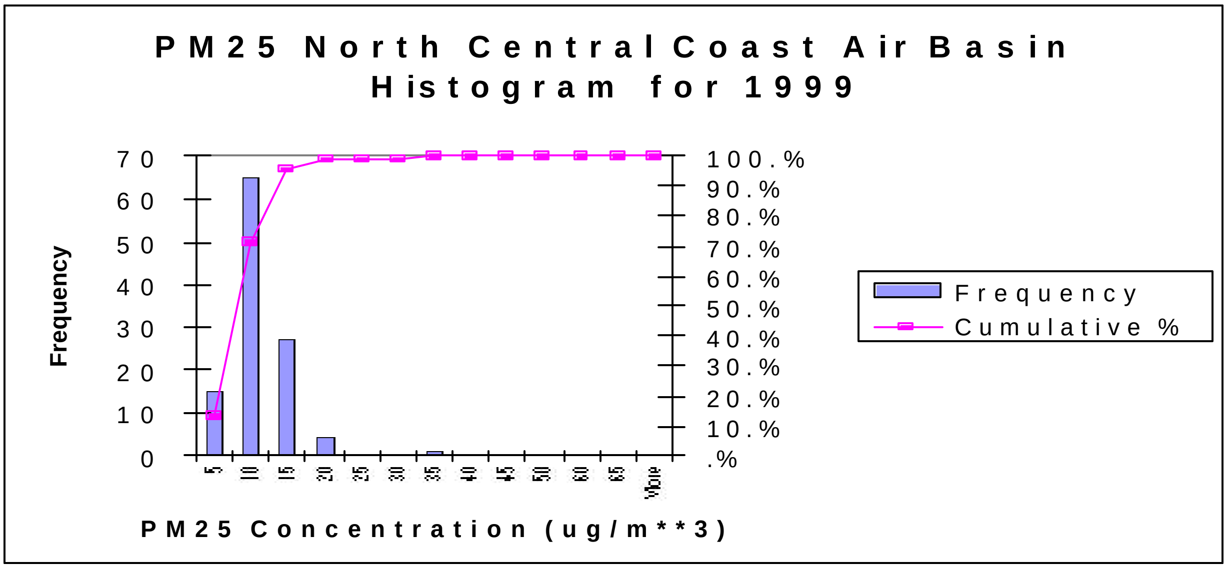
PM2.5 HISTOGRAMS FOR 1999

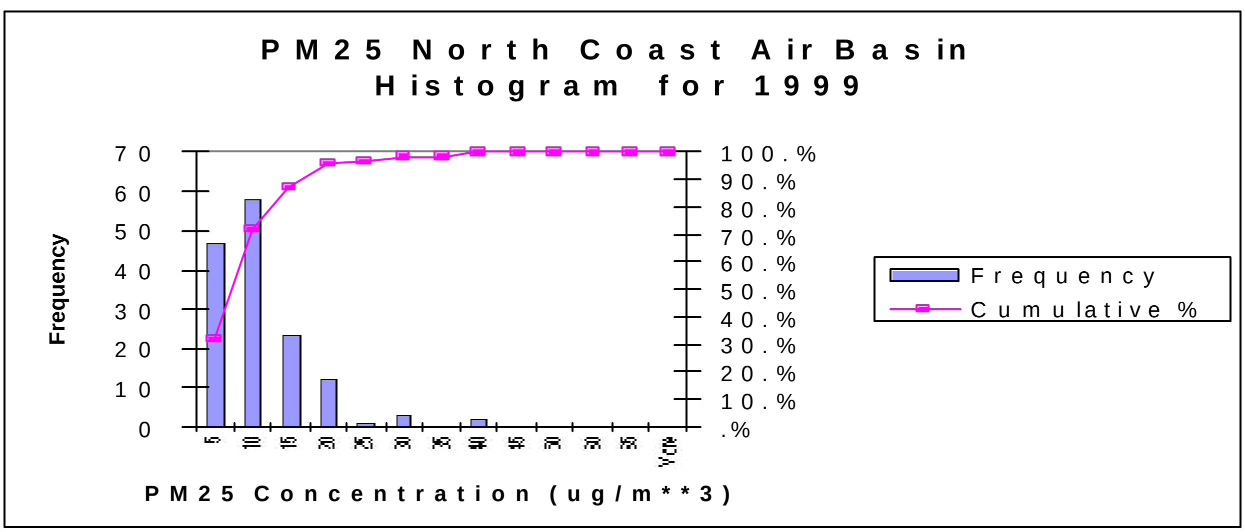

PM25 Great Basin Valley Air Basin
Histogram for 1999
Frequency
60
50
40
30
20
10
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

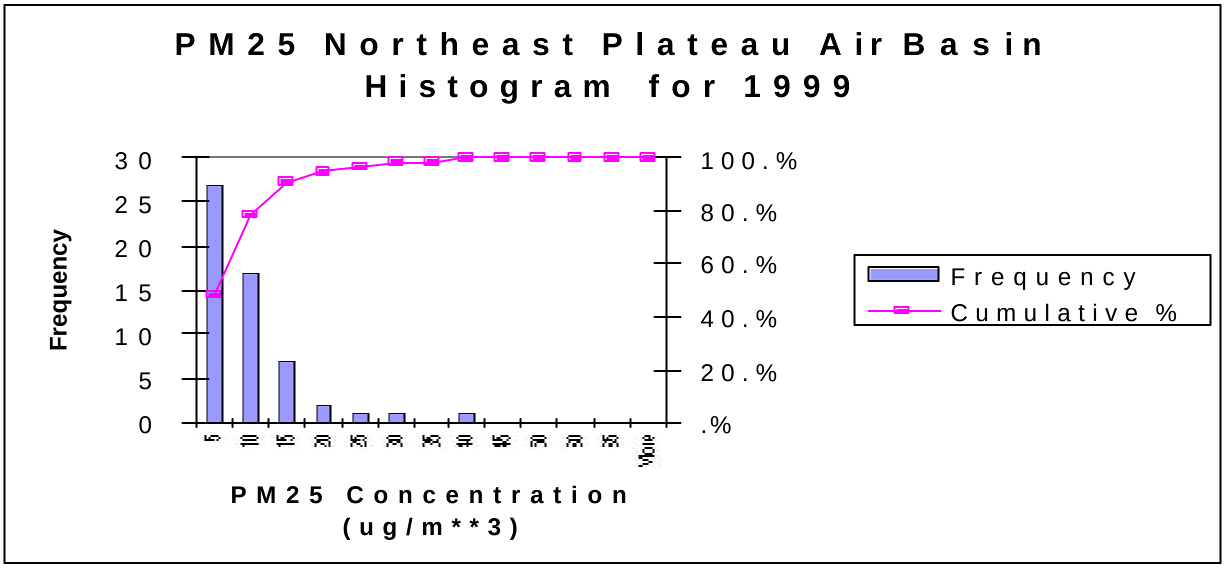

PM25 Lake Tahoe Air Basin
Histogram for 1999
Frequency
70
60
50
40
30
20
10
0
100.%
80.%
60.%
40.%
20.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

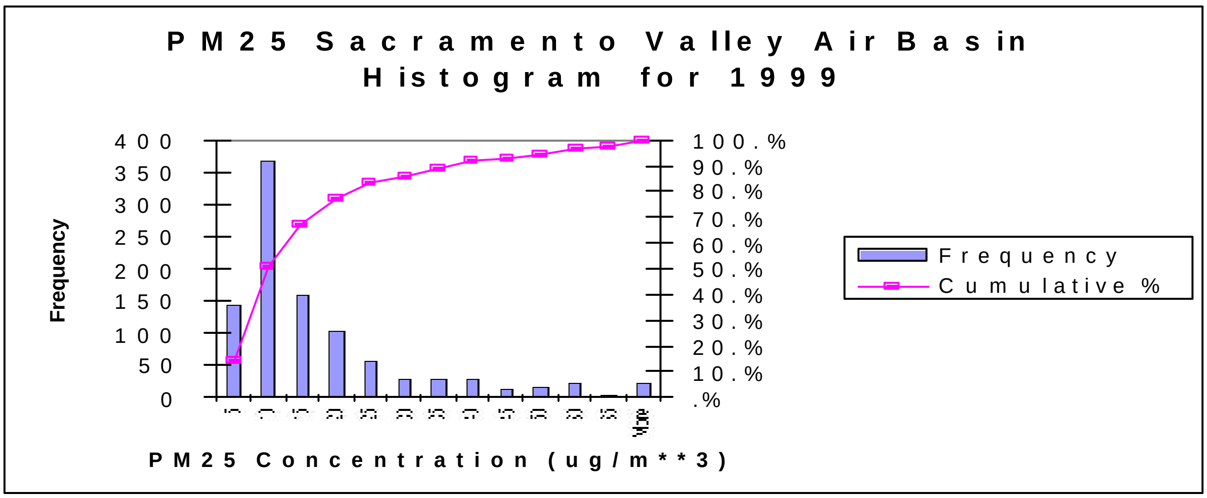

PM25 Mojave Desert Air Basin
Histogram for 1999
Frequency
180
160
140
120
100
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

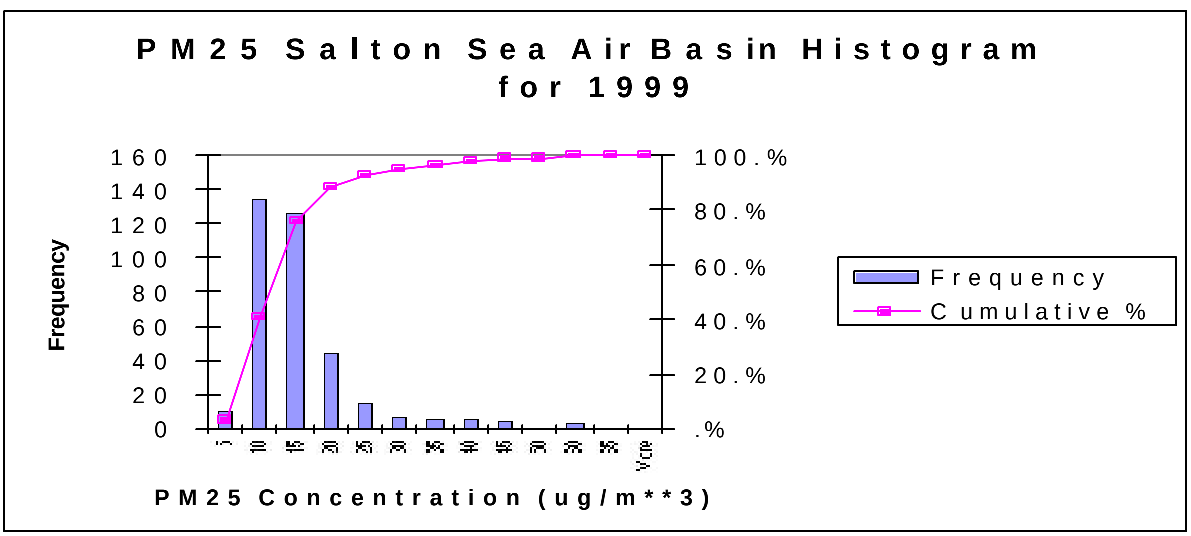

PM25 Mountain Counties Histogram for 1999
Frequency
160
140
120
100
80
60
40
20
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

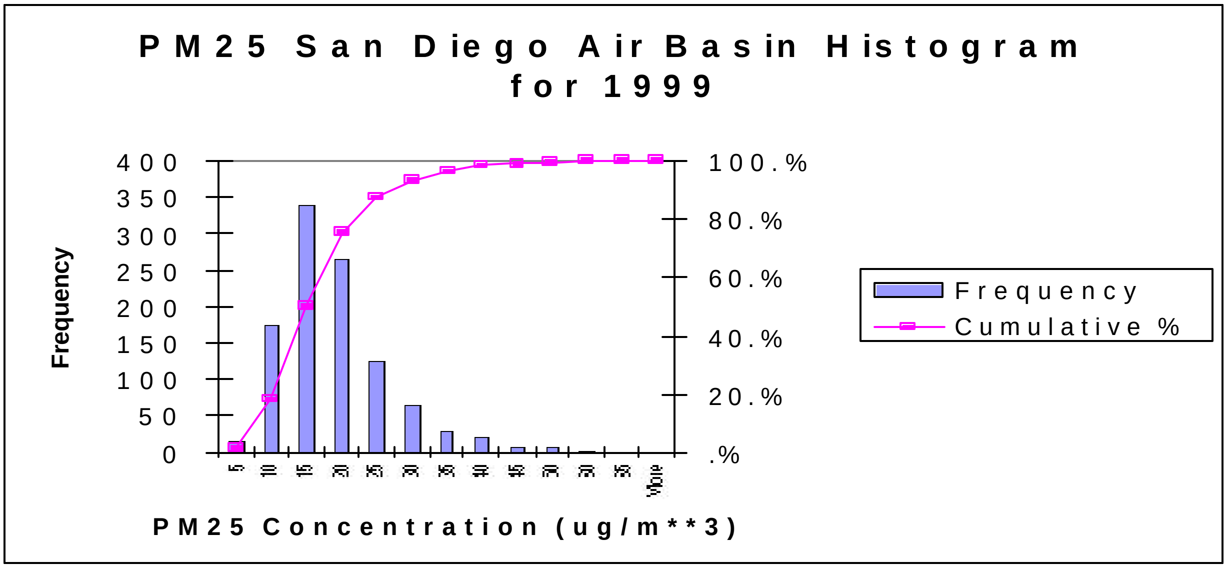

PM25 North Central Coast Air Basin Histogram for 1999
Frequency
70
60
50
40
30
20
10
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

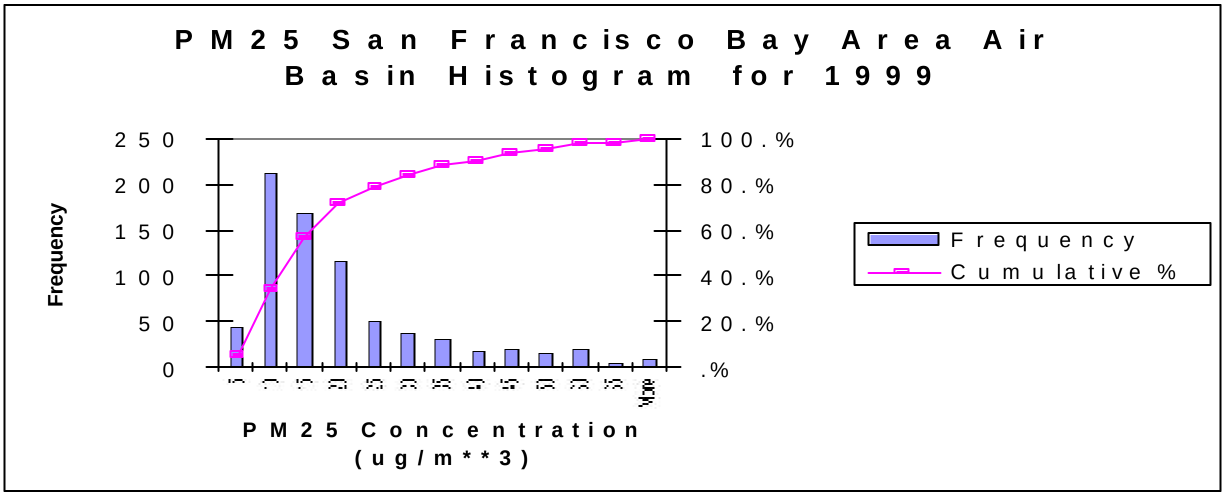

PM25 North Coast Air Basin Histogram for 1999
Frequency
70
60
50
40
30
20
10
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

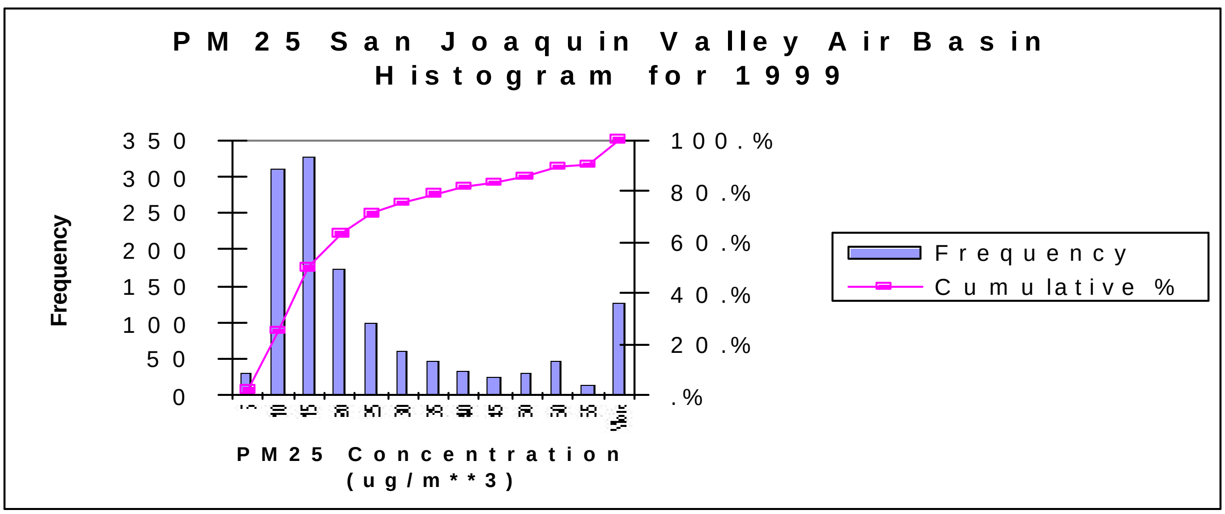

PM25 Northeast Plateau Air Basin
Histogram for 1999
Frequency
30
25
20
15
10
5
0
100.%
80.%
60.%
40.%
20.%
.%
PM25 Concentration
(ug/m**3)
Frequency
Cumulative %

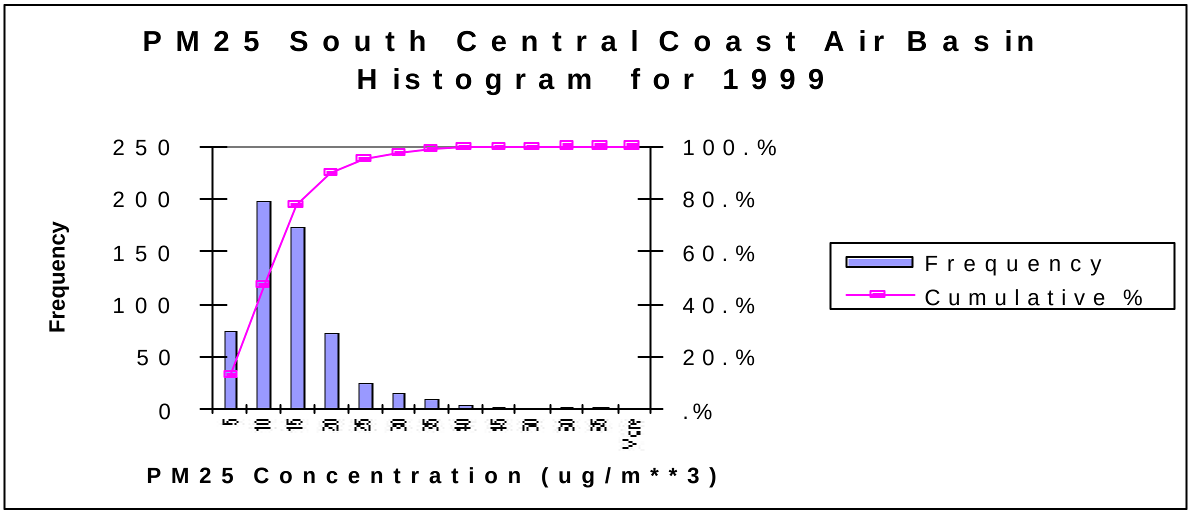

PM25 Sacramento Valley Air Basin
Histogram for 1999
Frequency
400
350
300
250
200
150
100
50
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
PM25 Concentration (ug/m**3)
Frequency
Cumulative %

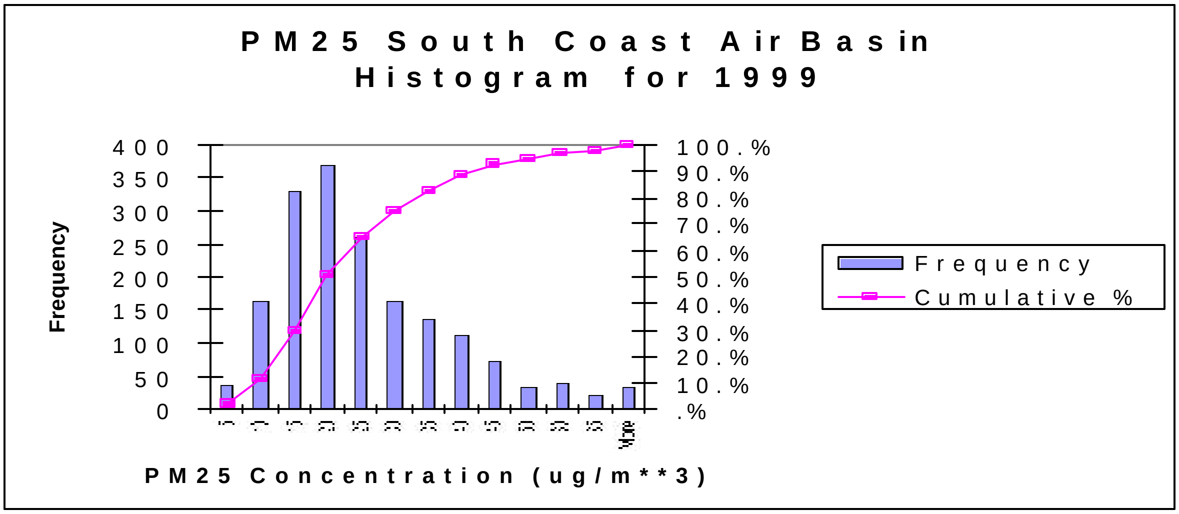

PM25 Salton Sea Air Basin Histogram
for 1999
Frequency
160
140
120
100
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
PM25 Concentration (ug/m**3)
Frequency
Cumulative %


PM25 San Diego Air Basin Histogram for 1999
Frequency
PM25 Concentration (ug/m**3)
Frequency
Cumulative %
400
350
300
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
More

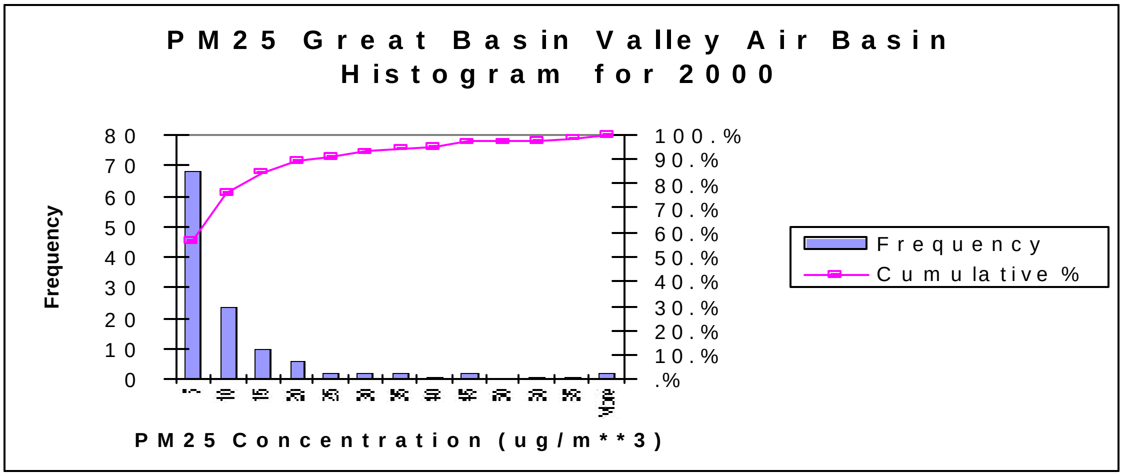

PM25 San Francisco Bay Area Air Basin Histogram for 1999
Frequency
PM25 Concentration (ug/m**3)
Frequency
Cumulative %
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
More

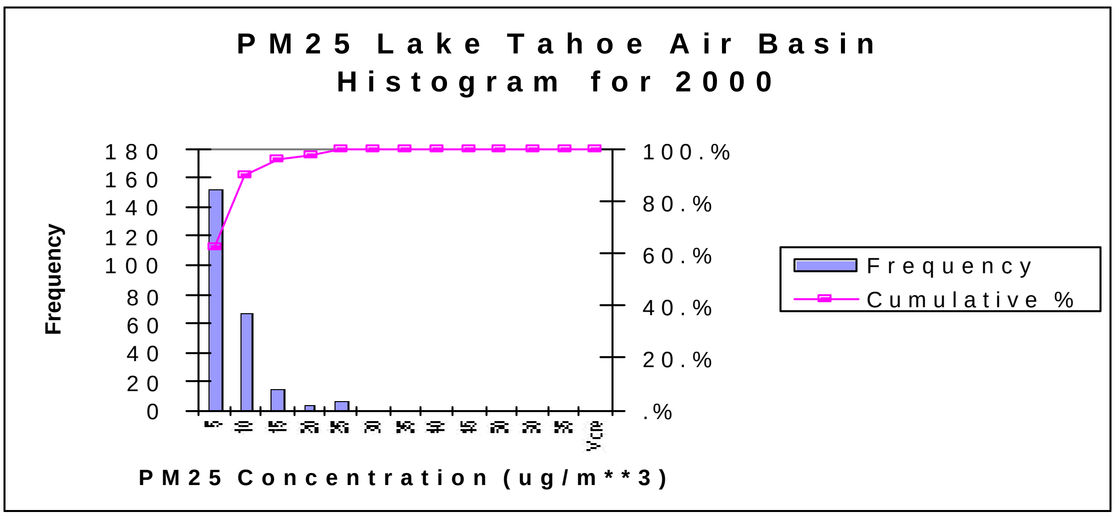

PM 25 San Joaquin Valley Air Basin Histogram for 1999
Frequency
PM25 Concentration (ug/m**3)
Frequency
Cumulative %
350
300
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
More

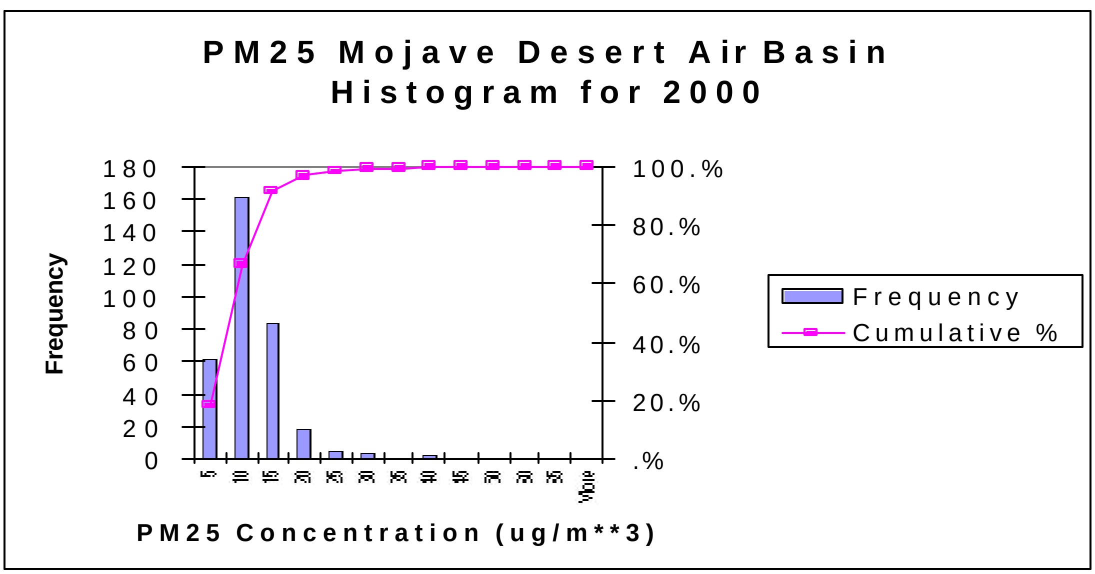

PM25 South Central Coast Air Basin
Histogram for 1999
Frequency
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

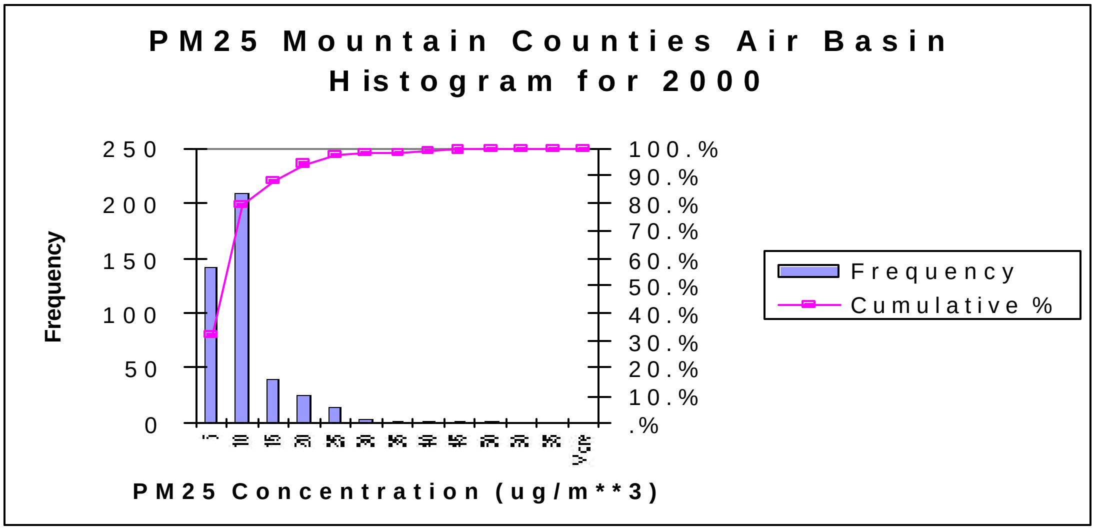

PM25 South Coast Air Basin
Histogram for 1999
Frequency
400
350
300
250
200
150
100
50
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

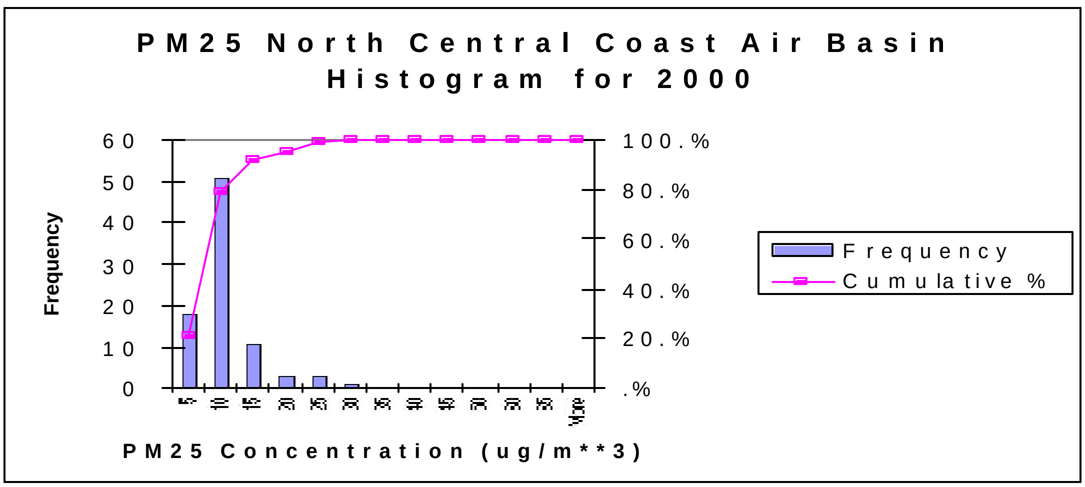
PM2.5 HISTOGRAMS FOR 2000

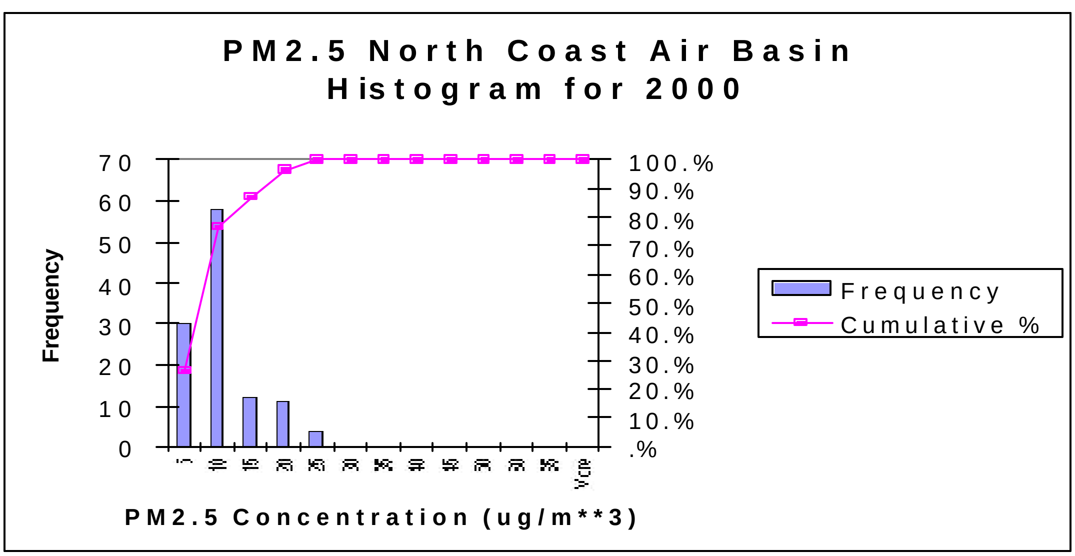

PM25 Great Basin Valley Air Basin
Histogram for 2000
Frequency
80
70
60
50
40
30
20
10
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

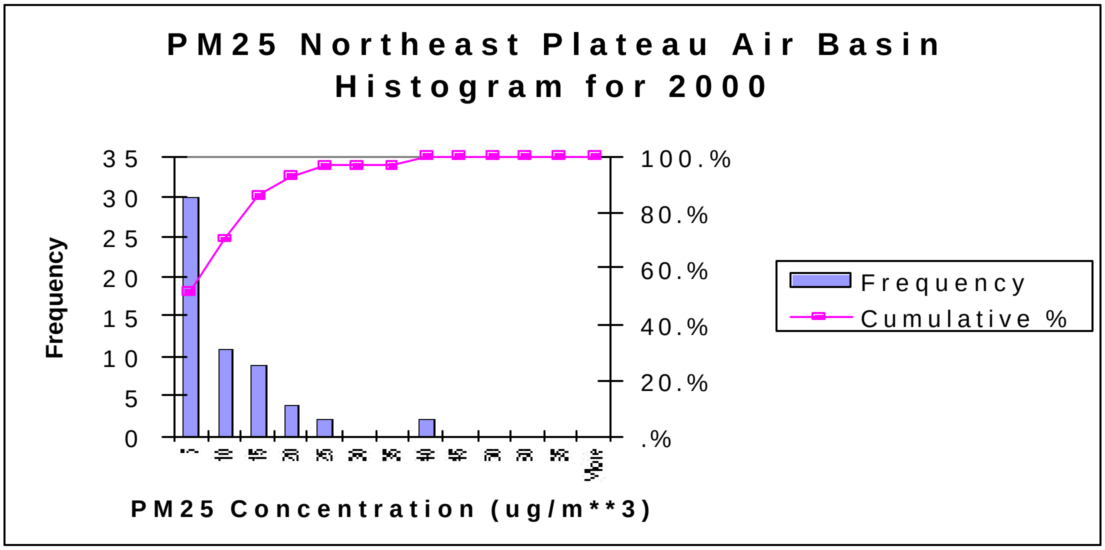

PM25 Lake Tahoe Air Basin
Histogram for 2000
Frequency
180
160
140
120
100
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

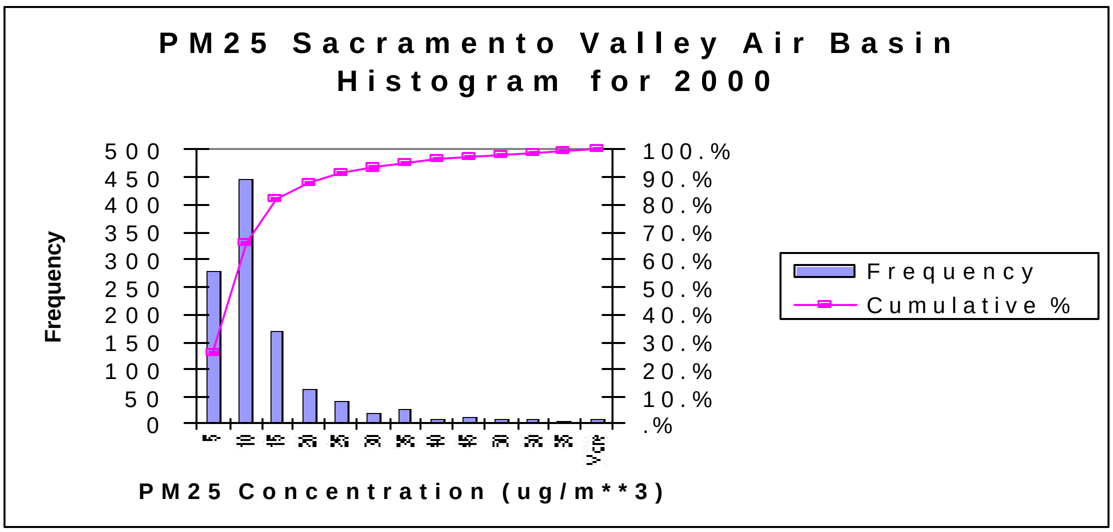

PM25 Mojave Desert Air Basin
Histogram for 2000
Frequency
180
160
140
120
100
80
60
40
20
0
100.%
80.%
60.%
40.%
20.%
.%
5
10
15
20
25
30
35
40
45
50
55
60
More
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

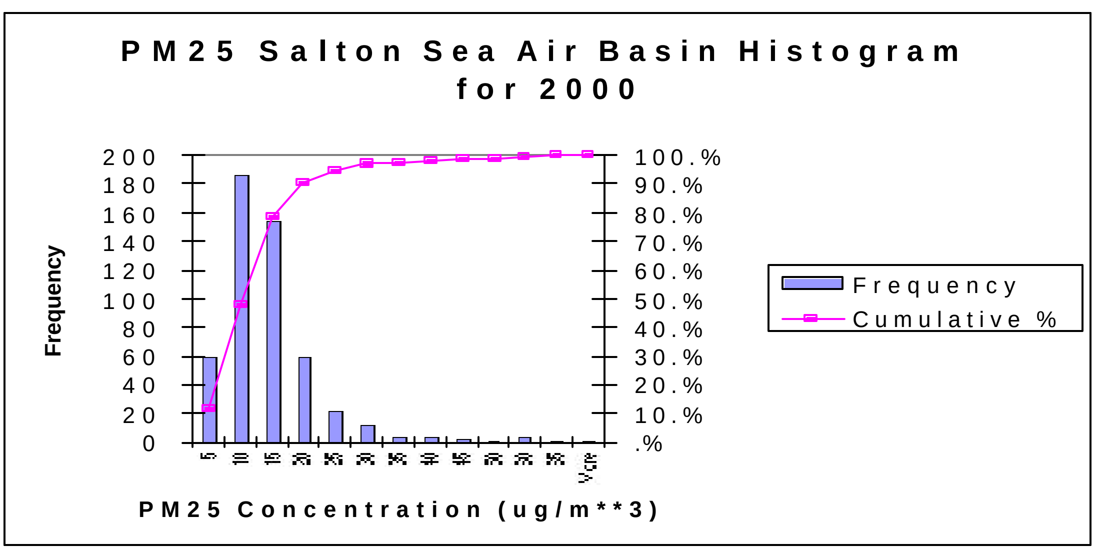

PM25 Mountain Counties Air Basin
Histogram for 2000
Frequency
250
200
150
100
50
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

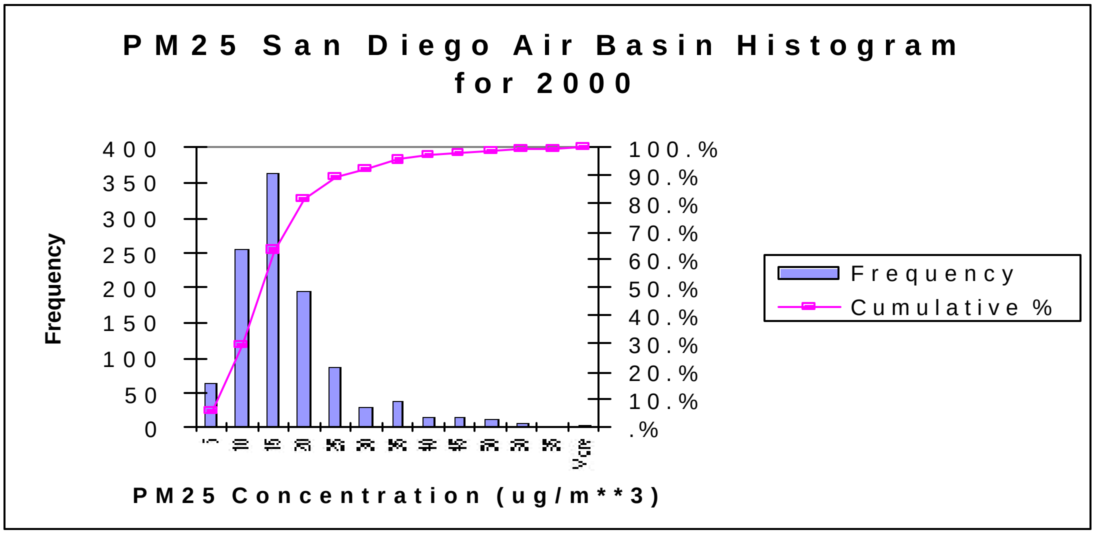

PM25 North Central Coast Air Basin
Histogram for 2000
Frequency
60
50
40
30
20
10
0
100.%
80.%
60.%
40.%
20.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

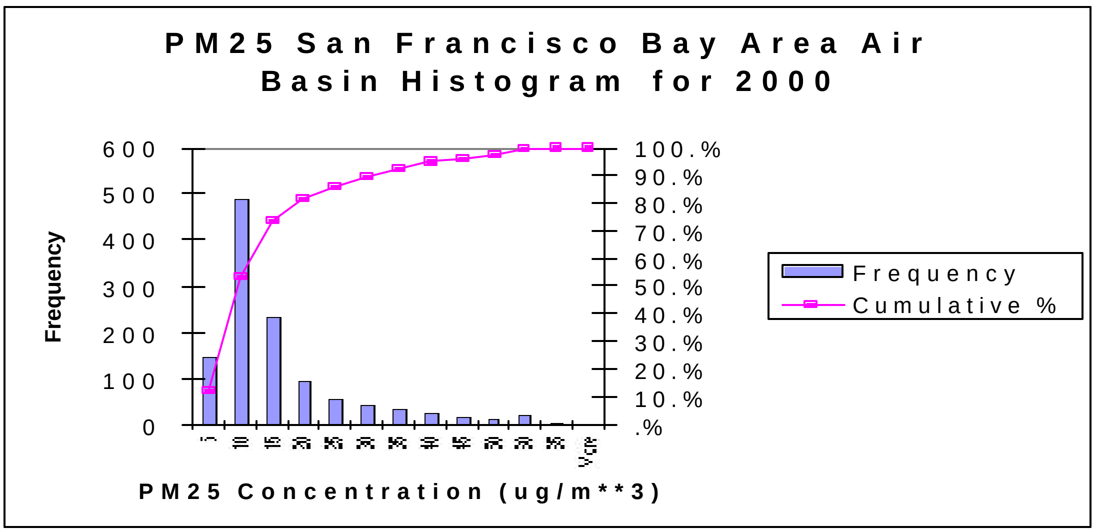

PM2.5 North Coast Air Basin
Histogram for 2000
Frequency
70
60
50
40
30
20
10
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM2.5 Concentration (ug/m**3)

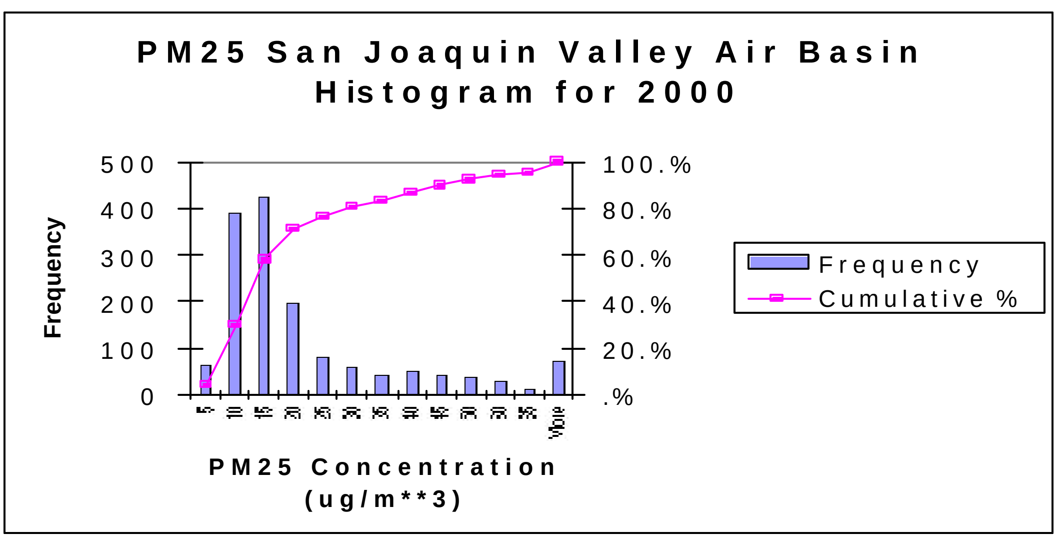

PM25 Northeast Plateau Air Basin
Histogram for 2000
Frequency
35
30
25
20
15
10
5
0
100.%
80.%
60.%
40.%
20.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

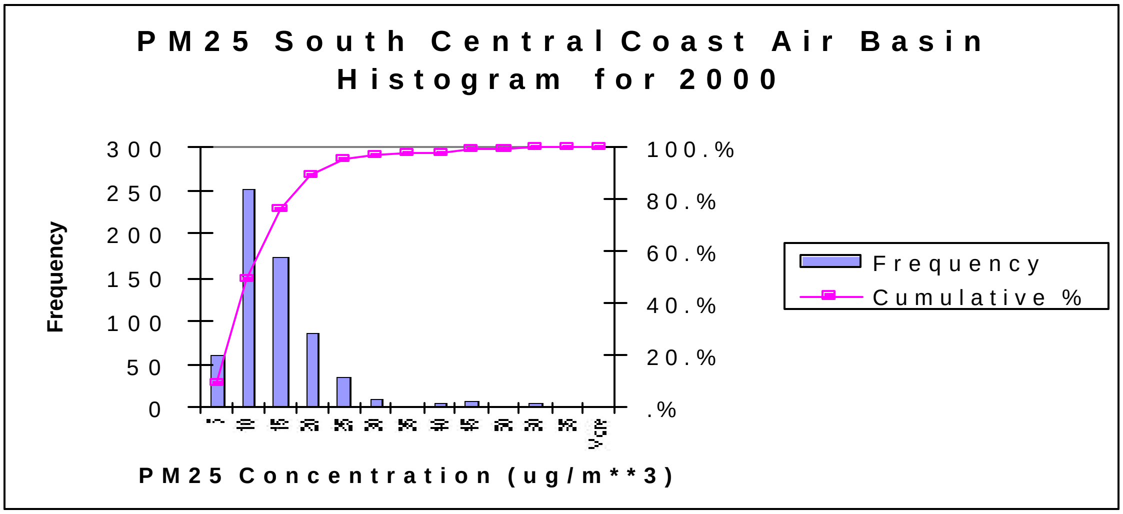

PM25 Sacramento Valley Air Basin
Histogram for 2000
Frequency
500
450
400
350
300
250
200
150
100
50
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)

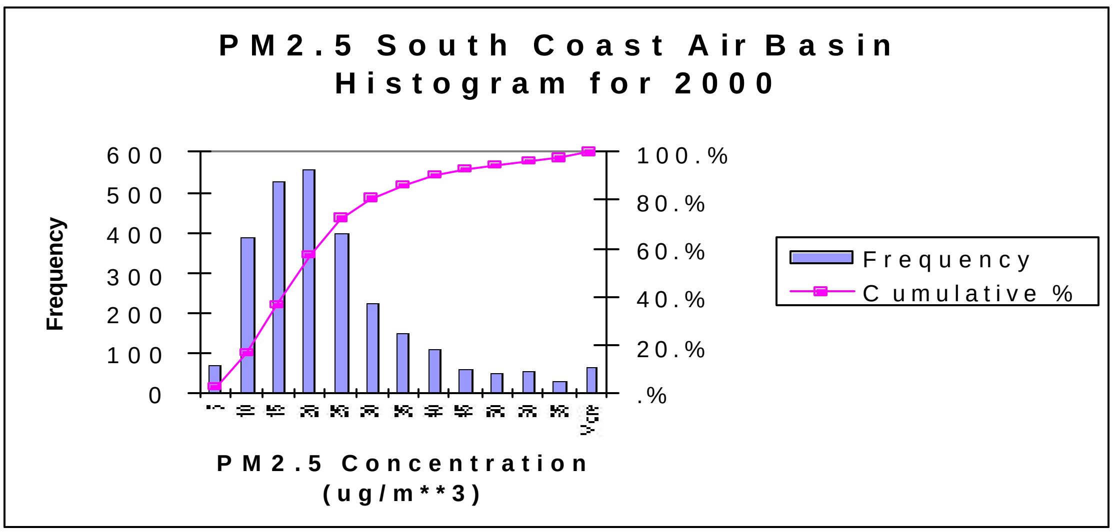

PM25 Salton Sea Air Basin Histogram
for 2000
Frequency
200
180
160
140
120
100
80
60
40
20
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)


PM25 San Diego Air Basin Histogram for 2000
Frequency
400
350
300
250
200
150
100
50
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)


PM25 San Francisco Bay Area Air Basin Histogram for 2000
Frequency
600
500
400
300
200
100
0
100.%
90.%
80.%
70.%
60.%
50.%
40.%
30.%
20.%
10.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)


PM25 San Joaquin Valley Air Basin Histogram for 2000
Frequency
500
400
300
200
100
0
100.%
80.%
60.%
40.%
20.%
.%
Frequency
Cumulative %
PM25 Concentration (ug/m**3)


PM25 South Central Coast Air Basin
Histogram for 2000
Frequency
300
250
200
150
100
50
0
100.%
80.%
60.%
40.%
20.%
.%
PM25 Concentration (ug/m**3)
Frequency
Cumulative %


PM2.5 South Coast Air Basin
Histogram for 2000
Frequency
600
500
400
300
200
100
0
100.%
80.%
60.%
40.%
20.%
.%
PM2.5 Concentration
(ug/m**3)
Frequency
Cumulative %

Appendix 6

Supplementary Material for Chapter 6

Part E
PM10 Summary of Population Exposure

Appendix VI-E1: PM10 Summary of Population Exposure by Air Basin for Annual Arthimetic Mean					
Air Basin	**Lower Concentra-tion Limit**	**Upper Concentra-tion Limit**	**1990 Popula-tion**	**Percent of Population Exposed**	**Percent Population Exposed to over 30 $\mu g/m^3$**
Great Basin Valley	5	10	1730	11.5%	0.0%
	10	15	9084	60.4%	0.0%
	15	20	844	5.6%	0.0%
	25	30	1703	11.3%	11.3%
	35	40	1687	11.2%	11.2%
		Total Pop Over 20.	**3390**	**Total Over 20**	**22.5**
Lake County	5	10	16877	33.3%	0.0%
	10	15	33754	66.7%	0.0%
Lake Tahoe	15	20	12970	33.3%	0.0%
	20	25	25939	66.7%	66.7%
		Total Pop.Over 20	25939	**Total Over 20**	66.7%
Mountain Counties	10	15	8001	2.6%	0.0%
	15	20	84700	27.4%	0.0%
	20	25	87451	28.3%	28.3%
	25	30	129069	41.7%	41.7%
		Total Pop.Over 20	216520	**Total Over 20**	70%
Mojave Desert	15	20	127100	48.5%	0.0%
	20	25	71516	27.3%	0.0%
	25	30	47325	18.0%	0.0%
	30	35	16275	6.2%	6.2%
		Total Pop.Over 20	**135116**	**Total Over 20**	**51.5%**
North Coast	10	15	74390	26.9%	0.0%
	15	20	133841	48.4%	0.0%
	20	25	60753	21.9%	21.9%

Appendix VI-E1: PM10 Summary of Population Exposure by Air Basin for Annual Arthimetic Mean

Air Basin	Lower Concentration Limit	Upper Concentration Limit	1990 Population	Percent of Population Exposed	Percent Population Exposed to over 30 $\mu g/m^3$
	25	30	7820	2.8%	2.8%
		Total Pop.Over 20	68573	**Total Over 20**	24.7%
North Central Coast	10	15	18605	3.0%	0.0%
	15	20	113751	18.3%	0.0%
	20	25	132194	21.2%	21.2%
	25	30	346885	55.8%	55.8%
	30	35	10656	1.7%	1.7%
		Total Pop. Over 20	**489735**	**Total Over 20**	**78.7%**
Northeast Plateau	5	10	20986	57.9%	0.0%
	10	15	2805	7.7%	0.0%
	15	20	3647	10.1%	0.0%
	20	25	5689	15.7%	15.7%
	25	30	3131	8.6%	8.6%
		Total Pop. Over 20	8820	**Total Over 20**	24.3%
South Coast	25	30	123818	1.0%	1.0%
	30	35	1837637	14.3%	14.3%
	35	40	5623658	43.7%	43.7%
	40	45	2489830	19.4%	19.4%
	45	50	1558886	12.1%	12.1%
	50	55	535075	4.2%	4.2%
	55	60	502120	3.9%	3.9%
	60	65	147693	1.1%	1.1%
	65	70	29602	0.2%	0.2%
	70	75	12829	0.1%	0.1%
		Total Pop. Over 20	**1281148**	**Total Over 20**	**100%**
South Central Coast	15	20	315418	25.3%	0.0%
	20	25	535278	42.9%	0.0%
	25	30	354807	28.4%	0.0%

Appendix VI-E1: PM10 Summary of Population Exposure by Air Basin for Annual Arthimetic Mean

Air Basin	Lower Concentration Limit	Upper Concentration Limit	1990 Population	Percent of Population Exposed	Percent Population Exposed to over 30 mg/m^3
	30	35	34218	2.7%	2.7%
	35	40	9406	0.8%	0.8%
		Total Pop. Over 20	**933709**	**Total Over 20**	**74%**
San Diego	20	25	482690	19.6%	19.6%
	25	30	887440	36.0%	36.0%
	30	35	1076136	43.6%	43.6%
	35	40	15293	0.6%	0.6%
	40	45	3449	0.1%	0.1%
	50	55	1724	0.1%	0.1%
		Total Pop. Over 20	**2466732**	**Total Over 20**	**100%**
San Francisco Bay Area	10	15	34219	0.6%	0.0%
	15	20	1828462	31.1%	0.0%
	20	25	3097355	52.7%	52.7%
	25	30	916746	15.6%	15.6%
		Total Pop. Over 20	4014101	**Total Over 20**	68.3%
San Joaquin Valley	20	25	100891	3.9%	3.9%
	25	30	274055	10.7%	10.7%
	30	35	420894	16.4%	16.4%
	35	40	618506	24.2%	24.2%
	40	45	423626	16.5%	16.5%
	45	50	359976	14.1%	14.1%
	50	55	305375	11.9%	11.9%
	55	60	56650	2.2%	2.2%
		Total Pop. Over 20	**2559973**	**Total Over 20**	**100%**
Salton Sea	25	30	13382	3.9%	3.9%
	30	35	42378	12.2%	12.2%
	35	40	26718	7.7%	7.7%
	40	45	15954	4.6%	4.6%

Appendix VI-E1: PM10 Summary of Population Exposure by Air Basin for Annual Arthimetic Mean					
Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 30 mg/m^3**
	45	50	70284	20.3%	20.3%
	50	55	70863	20.4%	20.4%
	55	60	14636	4.2%	4.2%
	60	65	5770	1.7%	1.7%
	65	70	1165	0.3%	0.3%
	70	75	3180	0.9%	0.9%
	75	80	4034	1.2%	1.2%
	80	85	1641	0.5%	0.5%
	85	90	1857	0.5%	0.5%
	90	95	5420	1.6%	1.6%
	95	100	2892	0.8%	0.8%
	100	105	11861	3.4%	3.4%
	105	110	6068	1.8%	1.8%
	115	120	1007	0.3%	0.3%
	125	130	2557	0.7%	0.7%
	130	135	3672	1.1%	1.1%
	135	140	514	0.1%	0.1%
	140	145	197	0.1%	0.1%
	145	150	384	0.1%	0.1%
	155	160	3679	1.1%	1.1%
	160	165	8159	2.4%	2.4%
	165	170	6584	1.9%	1.9%
	190	195	3672	1.1%	1.1%
	205	210	197	0.1%	0.1%
	210	215	384	0.1%	0.1%
	225	230	2224	0.6%	0.6%
	230	235	1455	0.4%	0.4%
	235	240	8159	2.4%	2.4%
	240	245	5577	1.6%	1.6%
		Total Pop. Over 20	**336044**	**Total Over 20**	**100%**
Sacramento Valley	15	20	133778	6.7%	0.0%
	20	25	1118015	55.6%	55.6%
	25	30	620612	30.9%	30.9%
	30	35	105063	5.2%	5.2%
	35	40	33930	1.7%	1.7%
		Total Pop. Over 20	**1877620**	**Total Over 20**	**93.4%**

\Appendix VI-E2: PM10 Summary of Population Exposure by Air Basin for Annual Geometric Mean					
Air Basin	**Upper PM10 Concentration Limit**	**Lower PM10 Concentration Limit**	**1990 Population**	**Percent of Pop. Exposed**	**Percent of Pop. Exposed to over 30 mg/m^3**
Great Basin Valley	5	10	6766	45.0%	0.0%
	10	15	5736	38.1%	0.0%
	15	20	2539	16.9%	0.0%
Lake County	5	10	33754	66.7%	0.0%
	10	15	16877	33.3%	0.0%
Lake Tahoe	15	20	38909	100.0%	0.0%
Mountain Counties	10	15	125234	45.2%	0.0%
	15	20	123331	44.5%	0.0%
	20	25	28800	10.4%	0.0%
Mojave Desert	10	15	19833	6.8%	0.0%
	15	20	50570	17.5%	0.0%
	20	25	102183	35.3%	0.0%
	25	30	94231	32.5%	0.0%
	30	35	22860	7.9%	**7.9%**
		Total Pop. Over 30	**22860**	**Total>30**	**7.9%**
North Coast	5	10	4072	1.5%	0.0%
	10	15	95130	34.4%	0.0%
	15	20	160396	57.9%	0.0%
	20	25	17207	6.2%	0.0%
North Central Coast	10	15	26122	4.2%	0.0%
	15	20	171769	27.6%	0.0%
	20	25	181195	29.1%	0.0%
	25	30	243006	39.1%	0.0%

Appendix VI-E2: PM10 Summary of Population Exposure by Air Basin for Annual Geometric Mean

Air Basin	Upper PM10 Concentration Limit	Lower PM10 Concentration Limit	1990 Population	Percent of Pop. Exposed	Percent of Pop. Exposed to over 30 mg/m^3
Northeast Plateau	0	5	9769	26.9%	0.0%
	5	10	12934	35.7%	0.0%
	10	15	4735	13.1%	0.0%
	15	20	5689	15.7%	0.0%
	20	25	3131	8.6%	0.0%
South Coast	20	25	108406	0.8%	0.0%
	25	30	1095339	8.5%	0.0%
	30	35	4374255	34.0%	**34.0%**
	35	40	3588468	27.9%	**27.9%**
	40	45	2430473	18.9%	**18.9%**
	45	50	748133	5.8%	**5.8%**
	50	55	376096	2.9%	**2.9%**
	55	60	87520	0.7%	**0.7%**
	60	65	44509	0.3%	**0.3%**
		Total Pop. Over 30	**11647806**	**Total >30**	**90.6%**
South Central Coast	10	15	23147	1.9%	0.0%
	15	20	562190	45.0%	0.0%
	20	25	319228	25.6%	0.0%
	25	30	344564	27.6%	0.0%
San Diego	20	25	671961	27.2%	0.0%
	25	30	904332	36.7%	0.0%
	30	35	616031	25.0%	**25.0%**
	35	40	164766	6.7%	**6.7%**
	40	45	83122	3.4%	**3.4%**
	45	50	26519	1.1%	**1.1%**
		Total Population Over 30	**890490**	**Total>30**	**36.1%**

Appendix VI-E2: PM10 Summary of Population Exposure by Air Basin for Annual Geometric Mean

Air Basin	Upper PM10 Concentration Limit	Lower PM10 Concentration Limit	1990 Population	Percent of Pop. Exposed	Percent of Pop. Exposed to over 30 mg/m^3
San Francisco Bay Area	10	15	410014	7.0%	0.0%
	15	20	2894258	49.2%	0.0%
	20	25	2557623	43.5%	0.0%
	25	30	14887	0.3%	0.0%
San Joaquin Valley	20	25	274618	10.7%	0.0%
	25	30	521003	20.4%	0.0%
	30	35	679915	26.6%	**26.6%**
	35	40	327096	12.8%	**12.8%**
	40	45	601304	23.5%	**23.5%**
	45	50	154871	6.0%	**6.0%**
	50	55	1165	<0.1%	<0.1%
		Total Pop. Over 30	**1828098**	**Total>30**	**68.9%**
Salton Sea	25	30	28538	8.2%	0.0%
	30	35	42749	12.3%	**12.3%**
	35	40	53701	15.5%	**15.5%**
	40	45	51256	14.8%	**14.8%**
	45	50	79074	22.8%	**22.8%**
	50	55	2480	0.7%	**0.7%**
	55	60	5671	1.6%	**1.6%**
	60	65	1869	0.5%	**0.5%**
	65	70	8340	2.4%	**2.4%**
	70	75	1472	0.4%	**0.4%**
	75	80	20595	5.9%	**5.9%**
	80	85	2360	0.7%	**0.7%**
	95	100	1247	0.4%	**0.4%**
	100	105	2317	0.7%	**0.7%**
	105	110	4186	1.2%	**1.2%**
	110	115	197	0.1%	**0.1%**
	115	120	384	0.1%	**0.1%**
	120	125	3679	1.1%	**1.1%**

Appendix VI-E2: PM10 Summary of Population Exposure by Air Basin for Annual Geometric Mean					
Air Basin	**Upper PM10 Concentration Limit**	**Lower PM10 Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent of Pop. Exposed to over 30 mg/m^3**
	125	130	14744	4.3%	**4.3%**
	145	150	3672	1.1%	**1.1%**
	155	160	197	0.1%	**0.1%**
	160	165	384	0.1%	**0.1%**
	170	175	3679	1.1%	**1.1%**
	175	180	8159	2.4%	**2.4%**
	180	185	5577	1.6%	**1.6%**
		Total Pop. Over 30	**321008**	**Total>30**	**91.8%**
Sacramento Valley	15	20	743175	36.9%	0.0%
	20	25	1166011	58.0%	0.0%
	25	30	55567	2.8%	0.0%
	30	35	46947	2.3%	**2.3%**
		Total Pop. Over 30	**46797**	**Total>30**	**2.3%**
Total Population			**28970817**		

Appendix VI-E3: PM10 Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration)					
Air Basin	**Lower Concentra-tion Limit**	**Upper Concentra-tion Limit**	**1990 Popula-tion**	**Percent of Population Exposed**	**Percent Population Exposed to over 50 mg/m^3**
Great Basin Valley	115	120	1595	19.0%	19.0%
	125	130	1724	20.5%	20.5%
	350	355	851	10.1%	10.1%
	360	365	851	10.1%	10.1%
	445	450	851	10.1%	10.1%
	515	520	844	10.0%	10.0%
	535	540	844	10.0%	10.0%
	645	650	844	10.0%	10.0%
		Total Pop. Over 50	**29350**	**Total Over 50**	**100.0%**
Lake County	25	30	16877	33.3%	0.0%
	45	50	33754	66.7%	0.0%
Lake Tahoe	60	65	12970	33.3%	33.3%
	65	70	12970	33.3%	33.3%
	75	80	12970	33.3%	33.3%
		Total Pop. Over 50	**38909**	**Total Over 50**	**100.0%**
Mountain Counties	50	55	31437	10.0%	10.0%
	55	60	47574	15.1%	15.1%
	60	65	4545	1.4%	1.4%
	65	70	34247	10.8%	10.8%
	70	75	46872	14.8%	14.8%
	75	80	5066	1.6%	1.6%
	80	85	6043	1.9%	1.9%
	85	90	26197	8.3%	8.3%
	90	95	8129	2.6%	2.6%
	95	100	6066	1.9%	1.9%
	100	105	10053	3.2%	3.2%
	105	110	3641	1.2%	1.2%
	110	115	5244	1.7%	1.7%
	115	120	4000	1.3%	1.3%

Appendix VI-E3: PM10 Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration)					
Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 50 mg/m^3**
	120	125	3404	1.1%	1.1%
	125	130	48745	15.4%	15.4%
	130	135	24546	7.8%	7.8%
		Total Pop. Over 50	**327404**	**Total Over 50**	**100.0%**
Mojave Desert	50	55	1186	0.4%	0.4%
	55	60	2723	1.0%	1.0%
	60	65	44283	15.9%	15.9%
	65	70	114959	41.3%	41.3%
	70	75	79522	28.6%	28.6%
	75	80	27863	10.0%	10.0%
	80	85	7957	2.9%	2.9%
		Total Pop. Over 50	**329128**	**Total Over 50**	**100.0%**
North Coast	30	35	7752	3.8%	0.0%
	35	40	1351	0.7%	0.0%
	40	45	4730	2.3%	0.0%
	45	50	16935	8.4%	0.0%
	50	55	20554	10.2%	10.2%
	55	60	61896	30.6%	30.6%
	60	65	44358	21.9%	21.9%
	65	70	29173	14.4%	14.4%
	85	90	15640	7.7%	7.7%
		Total Pop. Over 50	**241818**	**Total Over 50**	**84.8%**
North Central Coast	30	35	4937	0.8%	0.0%
	35	40	4366	0.7%	0.0%
	40	45	1290	0.2%	0.0%
	45	50	36783	5.9%	0.0%
	50	55	28095	4.5%	4.5%
	55	60	61756	9.9%	9.9%
	60	65	66517	10.7%	10.7%
	65	70	38324	6.2%	6.2%
	70	75	45310	7.3%	7.3%

Appendix VI-E3: PM10 Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration)					
Air Basin	**Lower Concentra-tion Limit**	**Upper Concentra-tion Limit**	**1990 Popula-tion**	**Percent of Population Exposed**	**Percent Population Exposed to over 50 mg/m^3**
	75	80	117282	18.9%	18.9%
	80	85	86988	14.0%	14.0%
	85	90	77675	12.5%	12.5%
	90	95	20056	3.2%	3.2%
	95	100	14832	2.4%	2.4%
	100	105	9077	1.5%	1.5%
	105	110	8803	1.4%	1.4%
		Total Pop. Over 50	**574812**	**Total Over 50**	**92.4%**
Northeast Plateau	25	30	5609	15.1%	0.0%
	35	40	7629	20.5%	0.0%
	40	45	4677	12.6%	0.0%
	50	55	1088	2.9%	2.9%
	55	60	1088	2.9%	2.9%
	65	70	628	1.7%	1.7%
	70	75	1931	5.2%	5.2%
	75	80	1256	3.4%	3.4%
	80	85	3861	10.4%	10.4%
	90	95	3131	8.4%	8.4%
	95	100	3131	8.4%	8.4%
	100	105	3131	8.4%	8.4%
		Total Pop. Over 50	**41858**	**Total Over 50**	**51.8%**
South Coast	55	60	2895	0.0%	0.0%
	65	70	9896	0.1%	0.1%
	70	75	69090	0.5%	0.5%
	75	80	316250	2.5%	2.5%
	80	85	1005520	7.8%	7.8%
	85	90	1488658	11.6%	11.6%
	90	95	1279968	10.0%	10.0%
	95	100	1774570	13.8%	13.8%
	100	105	1342119	10.4%	10.4%
	105	110	1345939	10.5%	10.5%
	110	115	809170	6.3%	6.3%

Appendix VI-E3: PM10 Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration)

Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 50 $\mu g/m^3$**
	115	120	666749	5.2%	5.2%
	120	125	752911	5.9%	5.9%
	125	130	633875	4.9%	4.9%
	130	135	427855	3.3%	3.3%
	135	140	293095	2.3%	2.3%
	140	145	222583	1.7%	1.7%
	145	150	143391	1.1%	1.1%
	150	155	107101	0.8%	0.8%
	155	160	61086	0.5%	0.5%
	160	165	45901	0.4%	0.4%
	165	170	22057	0.2%	0.2%
	170	175	19241	0.1%	0.1%
	175	180	14560	0.1%	0.1%
	180	185	7921	0.1%	0.1%
		Total Pop. Over 50	**12856298**	**Total Over 50**	**100.0%**
South Central Coast	35	40	11737	0.9%	0.0%
	40	45	10726	0.9%	0.0%
	45	50	144290	11.6%	0.0%
	50	55	242482	19.4%	19.4%
	55	60	279257	22.4%	22.4%
	60	65	194012	15.5%	15.5%
	65	70	156300	12.5%	12.5%
	70	75	79326	6.4%	6.4%
	75	80	12128	1.0%	1.0%
	80	85	3258	0.3%	0.3%
	85	90	21816	1.7%	1.7%
	90	95	14744	1.2%	1.2%
	95	100	15667	1.3%	1.3%
	100	105	12900	1.0%	1.0%
	105	110	17969	1.4%	1.4%
	110	115	18129	1.5%	1.5%
	115	120	4692	0.4%	0.4%
	120	125	5789	0.5%	0.5%
	125	130	3617	0.3%	0.3%
		Total Pop. Over 50	**1087337**	**Total Over 50**	**86.6%**

Appendix VI-E3: PM10 Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration)					
Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 50 $\mu g/m^3$**
San Diego	50	55	50688	2.1%	2.1%
	55	60	286493	11.6%	11.6%
	60	65	673280	27.3%	27.3%
	65	70	505173	20.5%	20.5%
	70	75	392213	15.9%	15.9%
	75	80	121601	4.9%	4.9%
	80	85	44101	1.8%	1.8%
	85	90	39880	1.6%	1.6%
	90	95	54735	2.2%	2.2%
	95	100	41010	1.7%	1.7%
	100	105	38164	1.5%	1.5%
	105	110	48261	2.0%	2.0%
	110	115	46898	1.9%	1.9%
	115	120	28759	1.2%	1.2%
	120	125	25410	1.0%	1.0%
	125	130	18801	0.8%	0.8%
	130	135	23655	1.0%	1.0%
	135	140	14128	0.6%	0.6%
	140	145	13482	0.5%	0.5%
		Total Pop. Over 50	**2466732**	**Total Over 50**	**100.0%**
San Francisco Bay Area	55	60	61668	1.0%	1.0%
	60	65	310010	5.3%	5.3%
	65	70	1110945	18.9%	18.9%
	70	75	850430	14.5%	14.5%
	75	80	663728	11.3%	11.3%
	80	85	1029675	17.5%	17.5%
	85	90	874154	14.9%	14.9%
	90	95	431597	7.3%	7.3%
	95	100	330266	5.6%	5.6%
	100	105	160550	2.7%	2.7%
	105	110	53759	0.9%	0.9%
		Total Pop. Over 50	**5876782**	**Total Over 50**	**100.0%**

Appendix VI-E3: PM10 Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration)					
Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 50 $\mu g/m^3$**
San Joaquin Valley	100	105	7173	0.3%	0.3%
	110	115	7173	0.3%	0.3%
	115	120	5266	0.2%	0.2%
	120	125	354208	13.8%	13.8%
	125	130	86053	3.4%	3.4%
	130	135	108546	4.2%	4.2%
	135	140	120574	4.7%	4.7%
	140	145	84260	3.3%	3.3%
	145	150	136684	5.3%	5.3%
	150	155	200111	7.8%	7.8%
	155	160	173248	6.8%	6.8%
	160	165	163489	6.4%	6.4%
	165	170	260859	10.2%	10.2%
	170	175	95042	3.7%	3.7%
	175	180	135293	5.3%	5.3%
	180	185	200495	7.8%	7.8%
	185	190	134083	5.2%	5.2%
	190	195	139551	5.5%	5.5%
	195	200	82493	3.2%	3.2%
	200	205	22267	0.9%	0.9%
	205	210	22104	0.9%	0.9%
	210	215	9671	0.4%	0.4%
	215	220	11329	0.4%	0.4%
		Total Pop. Over 50	**2653263**	**Total Over 50**	**100.0%**
Salton Sea	125	130	26635	7.7%	7.7%
	130	135	29885	8.6%	8.6%
	135	140	8600	2.5%	2.5%
	140	145	9842	2.8%	2.8%
	145	150	17459	5.0%	5.0%
	150	155	4155	1.2%	1.2%
	155	160	23561	6.8%	6.8%
	160	165	5663	1.6%	1.6%
	165	170	9370	2.7%	2.7%
	175	180	13522	3.9%	3.9%

Appendix VI-E3: PM10 Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration)					
Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 50 mg/m^3**
	180	185	95329	27.5%	27.5%
	195	200	2188	0.6%	0.6%
	210	215	4009	1.2%	1.2%
	215	220	2188	0.6%	0.6%
	220	225	2708	0.8%	0.8%
	225	230	2359	0.7%	0.7%
	230	235	4325	1.2%	1.2%
	245	250	1634	0.5%	0.5%
	265	270	651	0.2%	0.2%
	285	290	2317	0.7%	0.7%
	295	300	240	0.1%	0.1%
	315	320	514	0.1%	0.1%
	335	340	651	0.2%	0.2%
	345	350	1007	0.3%	0.3%
	355	360	1852	0.5%	0.5%
	365	370	465	0.1%	0.1%
	375	380	4306	1.2%	1.2%
	395	400	1873	0.5%	0.5%
	400	405	197	0.1%	0.1%
	410	415	384	0.1%	0.1%
	425	430	1422	0.4%	0.4%
	430	435	2257	0.7%	0.7%
	435	440	4302	1.2%	1.2%
	440	445	3858	1.1%	1.1%
	445	450	5577	1.6%	1.6%
	465	470	514	0.1%	0.1%
	485	490	1007	0.3%	0.3%
	555	560	3672	1.1%	1.1%
	560	565	1852	0.5%	0.5%
	585	590	465	0.1%	0.1%
	600	605	197	0.1%	0.1%
	615	620	651	0.2%	0.2%
	630	635	384	0.1%	0.1%
	660	665	1422	0.4%	0.4%
	665	670	802	0.2%	0.2%
	670	675	1455	0.4%	0.4%
	685	690	4302	1.2%	1.2%
	690	695	1915	0.6%	0.6%

Appendix VI-E3: PM10 Summary of Population Exposure by Air Basin For 24-Hour EPDC (Expected Peak Day Concentration)					
Air Basin	**Lower Concentra-tion Limit**	**Upper Concentra-tion Limit**	**1990 Popula-tion**	**Percent of Population Exposed**	**Percent Population Exposed to over 50 mg/m^3**
	695	700	1942	0.6%	0.6%
	700	705	3579	1.0%	1.0%
	705	710	1998	0.6%	0.6%
	730	735	240	0.1%	0.1%
	740	745	1634	0.5%	0.5%
	860	865	514	0.1%	0.1%
	875	880	1007	0.3%	0.3%
	1030	1035	1815	0.5%	0.5%
	1055	1060	1857	0.5%	0.5%
	1145	1150	197	0.1%	0.1%
	1230	1235	384	0.1%	0.1%
	1295	1300	2224	0.6%	0.6%
	1305	1310	1455	0.4%	0.4%
	1345	1350	2756	0.8%	0.8%
	1350	1355	1545	0.4%	0.4%
	1355	1360	1915	0.6%	0.6%
	1365	1370	1451	0.4%	0.4%
	1370	1375	491	0.1%	0.1%
	1375	1380	1460	0.4%	0.4%
	1380	1385	2119	0.6%	0.6%
	1395	1400	1998	0.6%	0.6%
		Total Pop. Over 50	**349682**	**Total Over 50**	**100.0%**
Sacramento Valley	55	60	37281	1.9%	1.9%
	60	65	7831	0.4%	0.4%
	65	70	88140	4.4%	4.4%
	70	75	115604	5.7%	5.7%
	75	80	113866	5.7%	5.7%
	80	85	126206	6.3%	6.3%
	85	90	192567	9.6%	9.6%
	90	95	326414	16.2%	16.2%
	95	100	279944	13.9%	13.9%
	100	105	69275	3.4%	3.4%
	105	110	103860	5.2%	5.2%
	110	115	131132	6.5%	6.5%
	115	120	126314	6.3%	6.3%

Appendix VI-E3: PM10 Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration)					
Air Basin	Lower Concentration Limit	Upper Concentration Limit	1990 Population	Percent of Population Exposed	Percent Population Exposed to over 50 mg/m^3
	120	125	83540	4.2%	4.2%
	125	130	34527	1.7%	1.7%
	130	135	26622	1.3%	1.3%
	135	140	13846	0.7%	0.7%
	140	145	9891	0.5%	0.5%
	145	150	14927	0.7%	0.7%
	150	155	8471	0.4%	0.4%
	155	160	3735	0.2%	0.2%
	160	165	4850	0.2%	0.2%
	165	170	5720	0.3%	0.3%
	170	175	41596	2.1%	2.1%
	180	185	1524	0.1%	0.1%
	195	200	3129	0.2%	0.2%
	200	205	8652	0.4%	0.4%
	205	210	32944	1.6%	1.6%
		Total Pop. Over 50	**2034668**	**Total Over 50**	**100.0%**
		Total Population	**28927544**		

Appendix VI-E4: PM10 Statewide Summary of Population Exposure for Annual Arthimetic Mean				
Lower Concentration Limit	**Upper Concentra-tion Limit**	**1990 Population Affected**	**Percent of Statewide Population**	**% Population Exposed to over 30 mg/m³**
10	15	180857	0.6%	0.0%
15	20	2754510	9.5%	9.5%
20	25	5717771	19.7%	19.7%
25	30	3726792	12.9%	12.9%
30	35	3543257	12.2%	**12.2%**
35	40	6329198	21.8%	**21.8%**
40	45	2932859	10.1%	**10.1%**
45	50	1989146	6.9%	**6.9%**
50	55	913038	3.2%	**3.2%**
55	60	573406	2.0%	**2.0%**
60	65	153463	0.5%	**0.5%**
65	70	30767	0.1%	**0.1%**
70	75	16009	0.1%	**0.1%**
75	80	4034	<0.1%	<0.1%
80	85	1641	<0.1%	<0.1%
85	90	1857	<0.1%	<0.1%
90	95	5420	<0.1%	<0.1%
95	100	2892	<0.1%	<0.1%
100	105	11861	<0.1%	<0.1%
105	110	6068	<0.1%	<0.1%
115	120	1007	<0.1%	<0.1%
125	130	2557	<0.1%	<0.1%
130	135	3672	<0.1%	<0.1%
135	140	514	<0.1%	<0.1%
140	145	197	<0.1%	<0.1%
145	150	384	<0.1%	<0.1%
155	160	3679	<0.1%	<0.1%
160	165	8159	<0.1%	<0.1%
165	170	6584	<0.1%	<0.1%
190	195	3672	<0.1%	<0.1%
205	210	197	<0.1%	<0.1%
210	215	384	<0.1%	<0.1%
225	230	2224	<0.1%	<0.1%
230	235	1455	<0.1%	<0.1%
235	240	8159	<0.1%	<0.1%
240	245	5577	<0.1%	<0.1%
	Total Pop. Over 20	**25990000**	**Total Over 20**	**89.5%**
Total Population		**28982857**		

Appendix VI-E5: PM10 Statewide Summary of Population Exposure for Annual Geometric Mean

Lower Concentra-tion Limit	Upper Concentra-tion Limit	1990 Population Affected	Percent of Statewide Population	% Population Exposed to Over 30 mg/m^{3}3
0	5	9769	0.0%	0.0%
5	10	57525	0.2%	0.0%
10	15	726829	2.5%	0.0%
15	20	4752824	16.4%	0.0%
20	25	5430362	18.7%	0.0%
25	30	3301467	11.4%	0.0%
30	35	5782757	20.0%	**20.0%**
35	40	4134031	14.3%	**14.3%**
40	45	3166155	10.9%	**10.9%**
45	50	1008597	3.5%	**3.5%**
50	55	379741	1.3%	**1.3%**
55	60	93191	0.3%	**0.3%**
60	65	46378	0.2%	**0.2%**
65	70	8340	<0.1%	<0.1%
70	75	1472	0.0%	<0.1%
75	80	20595	0.1%	<0.1%
80	85	2360	<0.1%	<0.1%
95	100	1247	<0.1%	<0.1%
100	105	2317	<0.1%	<0.1%
105	110	4186	<0.1%	<0.1%
110	115	197	<0.1%	<0.1%
115	120	384	<0.1%	<0.1%
120	125	3679	<0.1%	<0.1%
125	130	14744	<0.1%	<0.1%
145	150	3672	<0.1%	<0.1%
155	160	197	<0.1%	<0.1%
160	165	384	<0.1%	<0.1%
170	175	3679	<0.1%	<0.1%
175	180	8159	<0.1%	<0.1%
180	185	5577	<0.1%	<0.1%
	Total Pop. Over 30	**14688204**	**Total Over 30**	**50.7%**
Total Population		**28970817**		

Appendix VI-E6: PM10 Statewide Summary of Population Exposure for 24-Hour EPDC				
Lower Concentra-tion Limit	Upper Concentra-tion Limit	1990 Population Affected	Percent of Statewide Population	% Population Exposed to Over 50 μg/m^3
25	30	22486	0.1%	0.0%
30	35	12689	0.0%	0.0%
35	40	25082	0.1%	0.0%
40	45	21423	0.1%	0.0%
45	50	231762	0.8%	0.0%
50	55	375531	1.3%	1.3%
55	60	842631	2.9%	2.9%
60	65	1357805	4.7%	4.7%
65	70	2100754	7.3%	7.3%
70	75	1680296	5.8%	5.8%
75	80	1392011	4.8%	4.8%
80	85	2313608	8.0%	8.0%
85	90	2736588	9.5%	9.5%
90	95	2138773	7.4%	7.4%
95	100	2465484	8.5%	8.5%
100	105	1652441	5.7%	5.7%
105	110	1582234	5.5%	5.5%
110	115	1017747	3.5%	3.5%
115	120	837375	2.9%	2.9%
120	125	1225262	4.2%	4.2%
125	130	853977	3.0%	3.0%
130	135	641110	2.2%	2.2%
135	140	450243	1.6%	1.6%
140	145	340058	1.2%	1.2%
145	150	312461	1.1%	1.1%
150	155	319838	1.1%	1.1%
155	160	261629	0.9%	0.9%
160	165	219903	0.8%	0.8%
165	170	298007	1.0%	1.0%
170	175	155879	0.5%	0.5%
175	180	163376	0.6%	0.6%
180	185	305270	1.1%	1.1%
185	190	134083	0.5%	0.5%
190	195	139551	0.5%	0.5%
195	200	87810	0.3%	0.3%
200	205	30919	0.1%	0.1%
205	210	55048	0.2%	0.2%
210	215	13680	<0.1%	<0.1%

Appendix VI-E6: PM10 Statewide Summary of Population Exposure for 24-Hour EPDC				
Lower Concentration Limit	Upper Concentration Limit	1990 Population Affected	Percent of Statewide Population	% Population Exposed to Over 50 mg/m^3
215	220	13517	<0.1%	<0.1%
220	225	2708	<0.1%	<0.1%
225	230	2359	<0.1%	<0.1%
230	235	4325	<0.1%	<0.1%
245	250	1634	<0.1%	<0.1%
265	270	651	<0.1%	<0.1%
285	290	2317	<0.1%	<0.1%
295	300	240	<0.1%	<0.1%
315	320	514	<0.1%	<0.1%
335	340	651	<0.1%	<0.1%
345	350	1007	<0.1%	<0.1%
350	355	851	<0.1%	<0.1%
355	360	1852	<0.1%	<0.1%
360	365	851	<0.1%	<0.1%
365	370	465	<0.1%	<0.1%
375	380	4306	<0.1%	<0.1%
395	400	1873	<0.1%	<0.1%
400	405	197	<0.1%	<0.1%
410	415	384	<0.1%	<0.1%
425	430	1422	<0.1%	<0.1%
430	435	2257	<0.1%	<0.1%
435	440	4302	<0.1%	<0.1%
440	445	3858	<0.1%	<0.1%
445	450	6429	<0.1%	<0.1%
465	470	514	<0.1%	<0.1%
485	490	1007	<0.1%	<0.1%
515	520	844	<0.1%	<0.1%
535	540	844	<0.1%	<0.1%
555	560	3672	<0.1%	<0.1%
560	565	1852	<0.1%	<0.1%
585	590	465	<0.1%	<0.1%
600	605	197	<0.1%	<0.1%
615	620	651	<0.1%	<0.1%
630	635	384	<0.1%	<0.1%
645	650	844	<0.1%	<0.1%
660	665	1422	<0.1%	<0.1%
665	670	802	<0.1%	<0.1%

Appendix VI-E6: PM10 Statewide Summary of Population Exposure for 24-Hour EPDC				
Lower Concentra-tion Limit	**Upper Concentra-tion Limit**	**1990 Population Affected**	**Percent of Statewide Population**	**% Population Exposed to Over 50 mg/m^3**
670	675	1455	<0.1%	<0.1%
685	690	4302	<0.1%	<0.1%
690	695	1915	<0.1%	<0.1%
695	700	1942	<0.1%	<0.1%
700	705	3579	<0.1%	<0.1%
705	710	1998	<0.1%	<0.1%
730	735	240	<0.1%	<0.1%
740	745	1634	<0.1%	<0.1%
860	865	514	<0.1%	<0.1%
875	880	1007	<0.1%	<0.1%
1030	1035	1815	<0.1%	<0.1%
1055	1060	1857	<0.1%	<0.1%
1145	1150	197	<0.1%	<0.1%
1230	1235	384	<0.1%	<0.1%
1295	1300	2224	<0.1%	<0.1%
1305	1310	1455	<0.1%	<0.1%
1345	1350	2756	<0.1%	<0.1%
1350	1355	1545	<0.1%	<0.1%
1355	1360	1915	<0.1%	<0.1%
1365	1370	1451	<0.1%	<0.1%
1370	1375	491	<0.1%	<0.1%
1375	1380	1460	<0.1%	<0.1%
1380	1385	2119	<0.1%	<0.1%
1395	1400	1998	<0.1%	<0.1%
		Total Over 50		**98.9%**
Statewide Total Pop		**28927544**		

Appendix 6

Supplementary Material for Chapter 6

Part F

PM2.5 Summary of Population Exposure

Appendix VI-F1: Summary of Population Exposure by Air Basin for Annual Average of Quarters - PM2.5					
Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to Over 15 mg/m^3**
Great Basin Valley	5	10	16455	100.0%	0.0%
Lake County	0	5	16877	100.0%	0.0%
Lake Tahoe	5	10	25939	100.0%	0.0%
Mountain Counties	5	10	42401	57.2%	0.0%
	10	15	31666	42.8%	0.0%
Mojave Desert	5	10	2372	3.5%	0.0%
	10	15	65634	96.5%	0.0%
North Coast	5	10	120985	100.0%	0.0%
North Central Coast	5	10	197598	100.0%	0.0%
South Coast	10	15	137149	1.6%	0.0%
	15	20	1138817	13.3%	13.3%
	20	25	6262177	73.4%	73.4%
	25	30	985369	11.5%	11.5%
	30	35	9053	0.1%	0.1%
		Total Pop. Over 15	**8395416**	**Total Over 15**	**98.4%**
South Central Coast	5	10	116356	14.5%	0.0%
	10	15	688688	85.5%	0.0%
San Diego	10	15	601830	36.6%	0.0%
	15	20	1042658	63.4%	63.4%
		Total Pop. Over 15	**1042658**	**Total Over 15**	**63.4%**

Appendix VI-F1: Summary of Population Exposure by Air Basin for Annual Average of Quarters - PM25					
Air Basin	**Lower Concentra-tion Limit**	**Upper Concentra-tion Limit**	**1990 Popula-tion**	**Percent of Population Exposed**	**Percent Population Exposed to Over 15 mg/m^3**
San Francisco Bay Area	10	15	3580327	91.4%	0.0%
	15	20	337528	8.6%	8.6%
		Total Pop. Over 15	**337528**	**Total Over 15**	**8.6%**
San Joaquin Valley	10	15	173696	10.7%	0.0%
	15	20	691984	42.8%	42.8%
	20	25	407894	25.2%	25.2%
	25	30	343477	21.2%	21.2%
		Total Pop. Over 15	**1443355**	**Total Over 15**	**89.3%**
Salton Sea	10	15	181515	78.6%	0.0%
	15	20	49503	21.4%	21.4%
		Total Pop. Over 15	**49503**	**Total Over 15**	**21.4%**
Sacramento Valley	5	10	326983	24.5%	0.0%
	10	15	601319	45.0%	0.0%
	15	20	406601	30.5%	30.5%
		Total Pop. Over 15	**406601**	**Total Over 15**	**30.5%**
Total Exposed Population			**18602850**		

PM2.5 SUMMARY OF POPULATION EXPOSURE BY AIR BASIN FOR ANNUAL ARTHIMETIC MEAN

Air Basin	Lower Conc. Limit	Upper Conc. Limit	1990 Population Affected	Percent of Pop Exposed	Percent of Population Exposed to Over 12 ug/m**	Cumulative
Great Basin Valley	0	0	3112	15.9%		
	6	8	8227	42.0%		
	8	10	8227	42.0%		
		Total Basin Pop	19567			
Lake County	4	6	16877	100.0%		
		Total Basin Pop	16877			
Lake Tahoe	6	8	12970	50.0%		
	8	10	12970	50.0%		
		Total Basin Pop	25939			
Mountain Counties	0	0	144202	66.1%		
	6	8	11842	5.4%		
	8	10	30560	14.0%		
	10	12	4246	1.9%		
	12	14	1566	0.7%	0.7%	0.7%
	14	16	25853	11.8%	11.8%	11.8%
		Total Basin Pop	218269	Total Over 12	12.5%	12.5%
Mojave Desert	0	0	151412	69.0%		
	8	10	2372	1.1%		
	10	12	65634	29.9%		
		Total Basin Pop	219419			
North Coast	0	0	69137	36.4%		
	8	10	120985	63.6%		
		Total Basin Pop	190122			
North Central Coast	0	0	9766	4.7%		
	8	10	197598	95.3%		
		Total Basin Pop	207364			
Northeast Plateau	0	0	53871	100.0%		
		Total Basin Pop	53871			
South Coast	0	0	44665	0.5%		
	10	12	62197	0.7%		
	12	14	54816	0.6%	0.6%	0.6%
	14	16	78449	0.9%	0.9%	1.5%
	16	18	140237	1.6%	1.6%	3.1%
	18	20	940266	11.0%	11.0%	14.1%
	20	22	3288994	38.3%	38.3%	52.4%
	22	24	2406693	28.1%	28.1%	80.5%
	24	26	969847	11.3%	11.3%	91.8%
	26	28	386745	4.5%	4.5%	96.3%
	28	30	195267	2.3%	2.3%	98.6%
	30	32	9053	0.1%	0.1%	98.7%
		Total Basin Pop	8577229	Total Over 12	98.8%	98.8%
South Central Coast	0	0	32147	3.8%		
	8	10	116356	13.9%		

	10	12	192657	23.0%		
	12	14	393015	46.9%	46.9%	46.9%
	14	16	103016	12.3%	12.3%	59.2%
		Total Basin Pop	837191	Total Over 12	59.2%	59.2%
San Diego	0		1993	0.1%	0.1%	0.1%
	12	14	302418	18.4%	18.4%	18.5%
	14	16	871581	52.9%	52.9%	71.4%
	16	18	470489	28.6%	28.6%	100.0%
		Total Basin Pop	1646481	Total Over 12	100.0%	100.0%
San Francisco Bay Area	0	0	8	0.0%		
	10	12	1628421	41.6%		
	12	14	1461744	37.3%	37.3%	37.3%
	14	16	786947	20.1%	20.1%	57.4%
	16	18	40743	1.0%	1.0%	58.4%
		Total Basin Pop	3917863	Total Over 12	58.4%	58.4%
San Joaquin Valley	0	0	151791	8.6%		
	12	14	130654	7.4%	7.4%	7.4%
	14	16	100205	5.7%	5.7%	13.1%
	16	18	230949	13.1%	13.1%	13.1%
	18	20	403871	22.8%	22.8%	22.8%
	20	22	222815	12.6%	12.6%	12.6%
	22	24	115647	6.5%	6.5%	6.5%
	24	26	118983	6.7%	6.7%	6.7%
	26	28	266583	15.1%	15.1%	15.1%
	28	30	27343	1.5%	1.5%	1.5%
		Total Basin Pop	1768842	Total Over 12	91.4%	98.9%
Salton Sea	0	0	2103	0.9%		
	10	12	111503	47.8%		
	12	14	62184	26.7%	26.7%	26.7%
	14	16	30983	13.3%	13.3%	40.0%
	16	18	26348	11.3%	11.3%	51.3%
		Total Basin Pop	233121	Total Over 12	51.3%	51.3%
Sacramento Valley	0	0	21542	1.6%		
	6	8	97425	7.2%		
	8	10	229558	16.9%		
	10	12	339539	25.0%		
	12	14	131627	9.7%	9.7%	9.7%
	14	16	173797	12.8%	12.8%	22.5%
	16	18	284259	21.0%	21.0%	43.5%
	18	20	78699	5.8%	5.8%	49.3%
		Total Basin Pop	1356445	Total Over 12	49.3%	49.3%

Appendix VI-F3: Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration) for PM2.5					
Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 65 mg/m^3**
Great Basin Valley	0	5	13065	79.4%	0.0%
	75	80	3390	20.6%	**20.6%**
		Total Pop. Over 65	**3390**	**Total Over 65**	**20.6%**
Lake County	15	20	33754	100.0%	0.0%
Lake Tahoe	25	30	25939	100.0%	0.0%
Mountain Counties	35	40	54839	71.7%	0.0%
	40	45	8492	11.1%	0.0%
	75	80	13159	17.2%	**17.2%**
		Total Pop. Over 65	**13159**	**Total Over 65**	**17.2%**
Mojave Desert	25	30	131269	98.2%	0.0%
	30	35	2372	1.8%	0.0%
North Coast	30	35	46571	38.5%	0.0%
	35	40	74415	61.5%	0.0%
North Central Coast	15	20	120321	30.4%	0.0%
	20	25	48671	12.3%	0.0%
	25	30	226203	57.2%	0.0%
South Coast	35	40	8661	0.1%	0.0%
	40	45	913	0.0%	0.0%
	50	55	904	0.0%	0.0%
	65	70	206948	2.4%	**2.4%**
	70	75	47406	0.6%	**0.6%**
	75	80	709261	8.3%	**8.3%**
	80	85	2235575	26.2%	**26.2%**
	85	90	2313667	27.1%	**27.1%**
	90	95	2269317	26.6%	**26.6%**
	95	100	547279	6.4%	**6.4%**
	100	105	192633	2.3%	**2.3%**
		Total Population	**60014771**	**Total Over 65**	**99.9%**

		Over 65			
Appendix VI-F3: Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration) for PM2.5					
Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 65 mg/m^3**
South Central Coast	25	30	160451	22.3%	0.0%
	30	35	33563	4.7%	0.0%
	35	40	13168	1.8%	0.0%
	40	45	186573	26.0%	0.0%
	45	50	110527	15.4%	0.0%
	50	55	104531	14.6%	0.0%
	55	60	109344	15.2%	0.0%
San Diego	40	45	10251	0.6%	0.0%
	45	50	359336	21.9%	0.0%
	50	55	581731	35.4%	0.0%
	55	60	402795	24.5%	0.0%
	60	65	290375	17.7%	0.0%
San Francisco Bay Area	55	60	219161	5.6%	0.0%
	60	65	145418	3.7%	0.0%
	65	70	1671439	42.7%	**42.7%**
	70	75	723906	18.5%	**18.5%**
	75	80	943280	24.1%	**24.1%**
	80	85	149817	3.8%	**3.8%**
	85	90	64833	1.7%	**1.7%**
		Total Pop. Over 65	**3553275**	**Total Over 65**	**90.7%**
San Joaquin Valley	80	85	31433	1.8%	**1.8%**
	95	100	3727	0.2%	**0.2%**
	100	105	11321	0.7%	**0.7%**
	105	110	264253	15.5%	**15.5%**
	110	115	56257	3.3%	**3.3%**
	115	120	48755	2.9%	**2.9%**
	120	125	132180	7.7%	**7.7%**
	125	130	59307	3.5%	**3.5%**
	130	135	467735	27.4%	**27.4%**
	135	140	192700	11.3%	**11.3%**
	140	145	52385	3.1%	**3.1%**
	145	150	89021	5.2%	**5.2%**
	150	155	50878	3.0%	**3.0%**

	155	160	71563	4.2%	**4.2%**

Appendix VI-F3: Summary of Population Exposure by Air Basin for 24-Hour EPDC (Expected Peak Day Concentration) for PM2.5

Air Basin	**Lower Concentration Limit**	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 65 mg/m^3**
	160	165	123679	7.2%	**7.2%**
	165	170	28203	1.7%	**1.7%**
	170	175	23253	1.4%	**1.4%**
		Total Pop. Over 65	**1712187**	**Total Over 65**	**100.0%**
Salton Sea	35	40	160253	69.4%	0.0%
	55	60	22558	9.8%	0.0%
	60	65	31069	13.4%	0.0%
	65	70	3704	1.6%	**1.6%**
	70	75	13435	5.8%	**5.8%**
		Total Pop. Over 65	**17139**	**Total Over 65**	**7.4%**
Sacramento Valley	55	60	8314	0.6%	0.0%
	60	65	4612	0.3%	0.0%
	65	70	2449	0.2%	**0.2%**
	70	75	155568	11.6%	**11.6%**
	75	80	106298	8.0%	**8.0%**
	80	85	102572	7.7%	**7.7%**
	85	90	140859	10.5%	**10.5%**
	90	95	91813	6.9%	**6.9%**
	95	100	200253	15.0%	**15.0%**
	100	105	331125	24.8%	**24.8%**
	105	110	117929	8.8%	**8.8%**
	110	115	45249	3.4%	**3.4%**
	115	120	29722	2.2%	**2.2%**
		Total Pop. Over 65	**1323840**	**Total Over 65**	**99.0%**
Total Exposed Population			**18889953**		

Appendix VI-F4: Statewide Summary of Population Exposure for Annual Average of Quarters for PM2.5

Lower Concentration Limit	Upper Concentration Limit	1990 Population Affected	Percent of Statewide Population	% Population Exposed to > 15 μg/m^3
0	5	16877	0.1%	0.0%
5	10	849089	4.6%	0.0%
10	15	6061824	32.6%	0.0%
15	20	3667090	19.7%	**19.7%**
20	25	6670071	35.9%	**35.9%**
25	30	1328846	7.1%	**7.1%**
30	35	9053	0.0%	0.0%
	Total Pop. Over 15	**11666007**	**Total Over 15**	**62.8%**
Total Population Affected		**18602850**		

Appendix VI-F5: Summary of Statewide Population Exposure for EPDC (Expected Peak Day Concentration) for PM2.5				
Lower Concentration Limit	**Upper Concentration Limit**	**1990 Population**	**Percent of Population Exposed**	**Percent Population Exposed to over 65 mg/m^3**
0	5	13065	0.1%	0.0%
15	20	154075	0.8%	0.0%
20	25	48671	0.3%	0.0%
25	30	543862	2.9%	0.0%
30	35	82505	0.4%	0.0%
35	40	311336	1.6%	0.0%
40	45	206229	1.1%	0.0%
45	50	469863	2.5%	0.0%
50	55	687166	3.6%	0.0%
55	60	762172	4.0%	0.0%
60	65	471474	2.5%	0.0%
65	70	1884539	10.0%	**10.0%**
70	75	940315	5.0%	**5.0%**
75	80	1775388	9.4%	**9.4%**
80	85	2519398	13.3%	**13.3%**
85	90	2519359	13.3%	**13.3%**
90	95	2361130	12.5%	**12.5%**
95	100	751259	4.0%	**4.0%**
100	105	535079	2.8%	**2.8%**
105	110	382182	2.0%	**2.0%**
110	115	101506	0.5%	**0.5%**
115	120	78477	0.4%	**0.4%**
120	125	132180	0.7%	**0.7%**
125	130	59307	0.3%	**0.3%**
130	135	467735	2.5%	**2.5%**
135	140	192700	1.0%	**1.0%**
140	145	52385	0.3%	**0.3%**
145	150	89021	0.5%	**0.5%**
150	155	50878	0.3%	**0.3%**
155	160	71563	0.4%	**0.4%**
160	165	123679	0.7%	**0.7%**
165	170	28203	0.1%	**0.1%**
170	175	23253	0.1%	**0.1%**
	Total Pop. Over 65	**15130852**	**Total Over 65**	**80.1%**
Total Statewide Population Exposed		**18889953**		

Statewide Population Exposure for PM2.5 Annual Mean

Lower Concentration Limit	Upper Concentration Limit	1990 Population Affected	Percent of Statewide Population	% Population Exposed to Over 12 ug/m**3	Cumulative Exposure Over 12 ug/m**3
0	0	685750	3.6%		
4	6	16877	0.1%		
6	8	130464	0.7%		
8	10	718625	3.7%		
10	12	2404197	12.5%		
12	14	2538025	13.2%	13.2%	13.2%
14	16	2170831	11.3%	11.3%	24.5%
16	18	1193026	6.2%	6.2%	30.7%
18	20	1422836	7.4%	7.4%	38.1%
20	22	3511809	18.2%	18.2%	56.3%
22	24	2522340	13.1%	13.1%	69.4%
24	26	1088830	5.6%	5.6%	75.0%
26	28	653328	3.4%	3.4%	78.4%
28	30	222610	1.2%	1.2%	79.5%
30	32	9053	0.0%	0.0%	0.0%
	Total Pop	19288600	Sum over 12 ug/m**3	79.5%	79.5%

Appendix 6

Supplementary Material for Chapter 6

Part G
Population Data for PM10 Exposure Analysis

Appendix VI-G1: Population Data Used in Estimating PM10 Annual Geometric Mean Exposures

Air Basin	Total Population in Exposure Analysis	1990 Population	Percent Population in Exposure Analysis
Great Basin Valleys	15,041	29,350	51.2%
Lake County	50,631	50,631	100.0%
Lake Tahoe	38,909	38,909	100.0%
Mountain Counties	277,365	327,404	84.7%
Mojave Desert	289,678	329,128	88.0%
North Coast	276,804	285,183	97.1%
North Central Coast	622,091	622,091	100.0%
Northeast Plateau	36,258	80,807	44.9%
South Coast	12,853,199	12,856,298	100.0%
South Central Coast	1,249,128	1,255,586	99.5%
San Diego	2,466,732	2,469,721	100.0%
San Francisco Bay Area	5,876,782	5,876,794	100.0%
San Joaquin Valley	2,559,973	2,653,263	96.5%
Salton Sea	346,527	349,682	99.1%
Sacramento Valley	2,011,699	2,034,668	98.9%
Statewide	28,970,817	29,259,515	99.0%

Appendix VI-G2: Population Data Used in Estimating PM10 Average Annual Arithmetic Mean Exposures			
Air Basin	**Total Population in Exposure Analysis**	**1990 Population**	**Percent Population in Exposure Analysis**
Great Basin	15,041	29,350	51.2%
Lake County	50,631	50,631	100.0%
Lake Tahoe	38,909	38,909	100.0%
Mountain Counties	309,221	327,404	94.4%
Mojave Desert	262,217	329,128	79.7%
North Coast	276,804	285,183	97.1%
North Central Coast	622,091	622,091	100.0%
Northeast Plateau	36,258	80,807	44.9%
South Coast	12,861,147	12,856,298	100.0%
South Central Coast	1,249,128	1,255,586	99.5%
San Diego	2,466,732	2,469,721	99.9%
San Francisco Bay Area	5,876,782	5,876,794	100.0%
San Joaquin Valley	2,559,973	2,653,263	96.5%
Salton Sea	346,527	349,682	99.1%
Sacramento Valley	2,011,397	2,034,668	98.9%
Statewide	28,982,858	29,259,515	99.0%

Appendix VI-G3: Population Data Used in Estimating PM10 Expected Peak Day Exposures

Air Basin	Total Population in Exposure Analysis	1990 Population	Percent Population in Exposure Analysis
Great Basin Valleys	8,404	29,350	28.6%
Lake County	50,631	50,631	100.0%
Lake Tahoe	38,909	38,909	100.0%
Mountain Counties	315,808	327,404	96.5%
Mojave Desert	278,492	329,128	84.6%
North Coast	202,389	285,183	71.0%
North Central Coast	622,091	622,091	100.0%
Northeast Plateau	37,159	80,807	46.0%
South Coast	12,862,399	12,856,298	100.0%
South Central Coast	1,248,838	1,255,586	99.5%
San Diego	2,466,732	2,469,721	99.9%
San Francisco Bay Area	5,876,782	5,876,794	100.0%
San Joaquin Valley	2,559,973	2,653,263	96.5%
Salton Sea	346,527	349,682	99.1%
Sacramento Valley	2,012,410	2,034,668	98.9%
Statewide	28,927,544	29,259,515	98.9%

Appendix 6

Supplementary Material for Chapter 6

Part H
Population Data for PM2.5 Exposure Analysis

Appendix VI-H1: Summary of PM2.5 Average of Quarters (AOQ)

Air Basin	Total Population in Exposure Analysis	1990 Population	Percent Population in Exposure Analysis
Great Basin Valley	16,445	29,350	56.0%
Lake County	16,877	50,631	33.3%
Lake Tahoe	25,939	38,909	66.7%
Mountain Counties	74,067	327,404	22.6%
Mojave Desert	68,006	329,128	20.7%
North Coast	120,985	285,183	42.4%
North Central Coast	197,598	622,091	31.8%
Northeast Plateau	NA	80,807	NA
South Coast	8,532,564	12,856,298	66.4%
South Central Coast	805,044	1,255,586	64.1%
San Diego	1,644,488	2,469,721	66.6%
San Francisco Bay Area	3,917,855	5,876,794	66.7%
San Joaquin Valley	1,617,051	2,653,263	60.9%
Salton Sea	231,018	349,682	66.1%
Sacramento Valley	1,334,903	2,034,668	65.6%
Statewide	18,082,923	29,259,515	61.8%

Appendix VI-H2: Population Data Used for Calculating PM2.5 Average of 24-Hour EPDC Exposures			
Air Basin	**Total Population in Exposure Analysis**	**1990 Population**	**Percent Population in Exposure Analysis**
Great Basin Valley	16,554	29,350	56.4%
Lake County	33,754	50,631	66.7%
Lake Tahoe	25,940	38,909	66.7%
Mountain Counties	76,490	327,404	23.4%
Mojave Desert	133,640	329,128	40.6%
North Coast	120,986	285,183	42.4%
North Central Coast	395,196	622,091	63.5%
Northeast Plateau	NA	80,807	NA
South Coast	8,532,564	12,856,298	66.4%
South Central Coast	718,158	1,255,586	57.2%
San Diego	1,644,488	2,469,721	66.6%
San Francisco Bay Area	3,917,854	5,876,794	66.7%
San Joaquin Valley	1,670,448	2,653,263	63.0%
Salton Sea	231,018	349,682	66.1%
Sacramento Valley	1,336,762	2,034,668	65.7%
Statewide	18,051,292	29,259,515	61.7%